Iron AND Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

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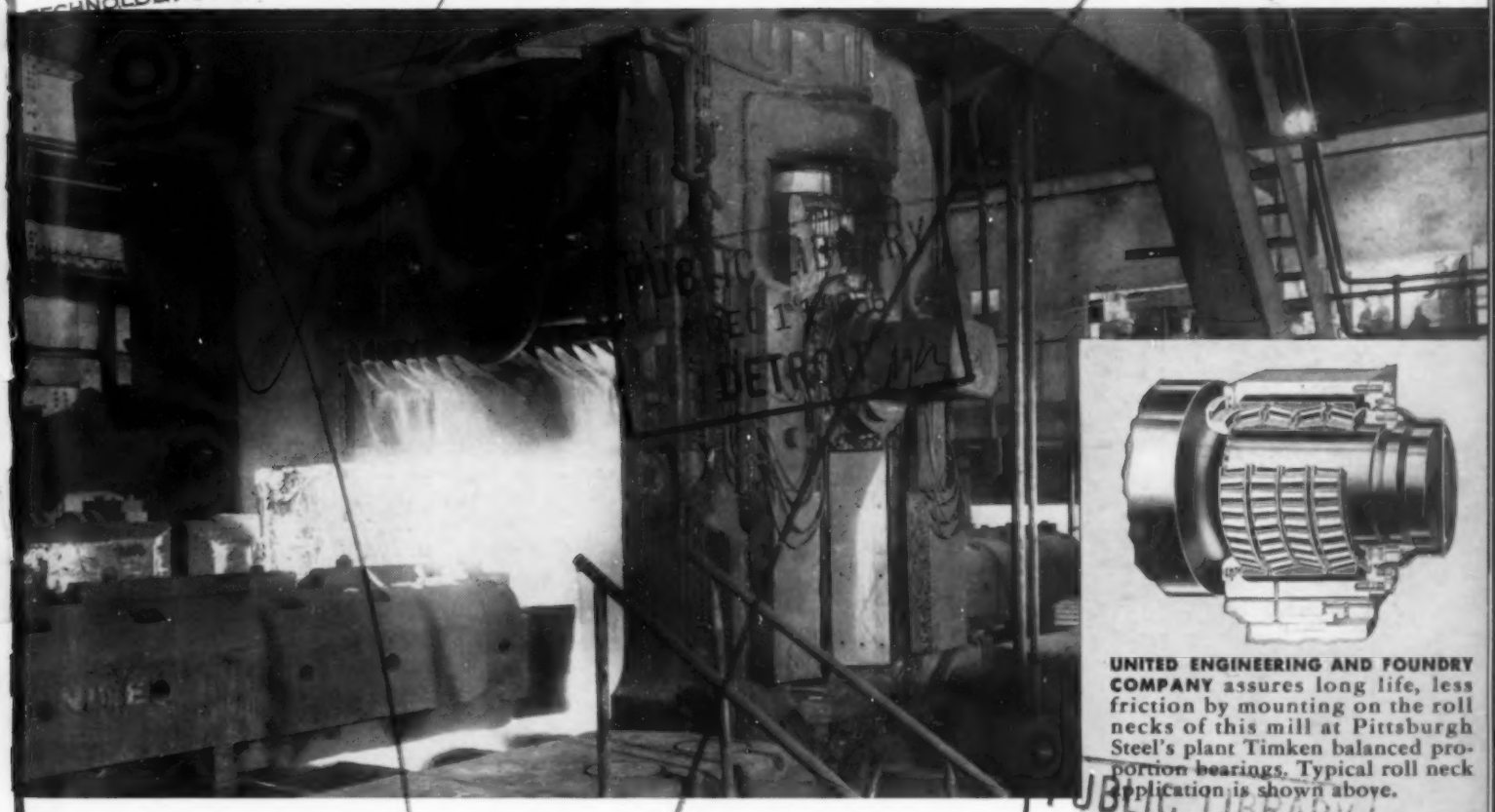
TECHNOLOGY DEPT.



UNITED ENGINEERING AND FOUNDRY COMPANY assures long life, less friction by mounting on the roll necks of this mill at Pittsburgh Steel's plant Timken balanced proportion bearings. Typical roll neck application is shown above.

PUBLIC LIBRARY
DEC 11 1956
DETROIT

New slabbing mill gains 50% in roll neck strength with TIMKEN® balanced proportion bearings

THIS 2-high blooming mill, built by United Engineering and Foundry Company, is part of Pittsburgh Steel's $65 million "Program of Progress". To help make sure steel is rolled at the lowest possible cost-per-ton, Timken® balanced proportion bearings are used on the roll necks.

The balanced proportion design of Timken bearings provides a maximum amount of capacity in a given space. Larger diameter roll necks are made possible with no increase in bearing O.D. Load ratings are increased up to 40%, roll neck strength 50 to 60%!

Timken bearings eliminate complicated lubrication systems, permit the use of simple and economical grease lubrication. Rolls can be changed quickly and easily. No special thrust bearings are needed because Timken bearings take both radial and thrust loads in any combination.

Higher rolling speeds are possible with Timken bearings because they operate freely, practically without friction. Wear is kept to a minimum, long life is assured. Timken bearings are designed to roll true and precision manufactured to live up to their design. We even make our own steel to *insure* quality control. We're the only U. S. bearing manufacturer that does.

Next time, be sure to specify Timken balanced proportion roll neck bearings. For full details, consult our roll neck specialists. Write The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ont. Cable: "TIMROSCO".

This symbol on a product means its bearings are the best.

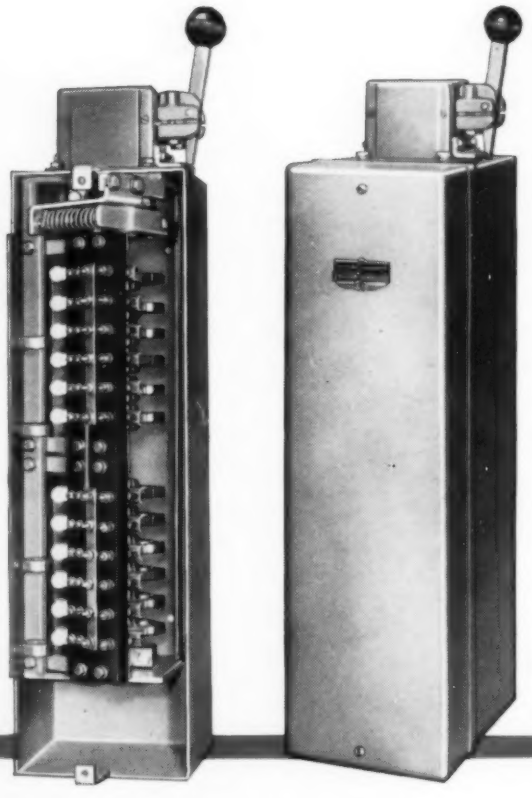
TIMKEN TAPERED ROLLER BEARINGS ROLL THE LOAD

NOW— the "THIN" MASTER

for crowded cab and pulpit space

The new Cutler-Hammer Bulletin 14951 Type D Cam Master Switch measures only 7⅝ inches wide. It's designed especially for crane cab or mill pulpit use where space is at a premium. 4 of them will fit in 30 inches, all within easy reach of the operator. You can have this new master switch with bevel gear type handle which can easily be set in any one of 4 positions 90° apart. Or with radial type operating handle. Operating handle "feel" or tension is easily adjustable. Off position latch is optional. Spring return easily available. All adjustments made in field. You can have it in 6, 12, or 16 circuits. Overall case length, 16, 25¼ and 30" respectively. A maximum of 6 speed points in either direction. Available as open type for benchboard mounting, or enclosed type for base mounting.

All parts of this new master are easily and completely accessible for wiring, installation and inspection. Simply remove cover—there's ample wiring space about the terminal board. A wire way is provided on left side of terminal board. Contact fingers and cams can be removed individually—easily and quickly. This entirely new switch employs basic principles of design and construction tested and proved over many years of service in the metal working and allied industries. Save space. Save installation and wiring costs. Save operator fatigue. Get better, more dependable operation. Order bulletin 14951 *now*. CUTLER-HAMMER, Inc., 1269 St. Paul Avenue, Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ontario.



Easy to install, wire and inspect

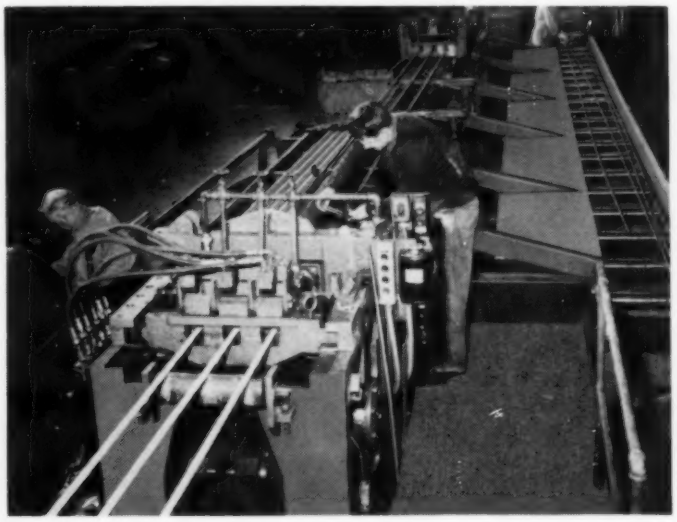
CUTLER-HAMMER
MOTOR CONTROL
C-H

IRON AND STEEL ENGINEER; published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., Pittsburgh, Pa. Second class mail privileges authorized at Pittsburgh, Pennsylvania, January 25, 1924.

new ideas in COLD DRAW equipment

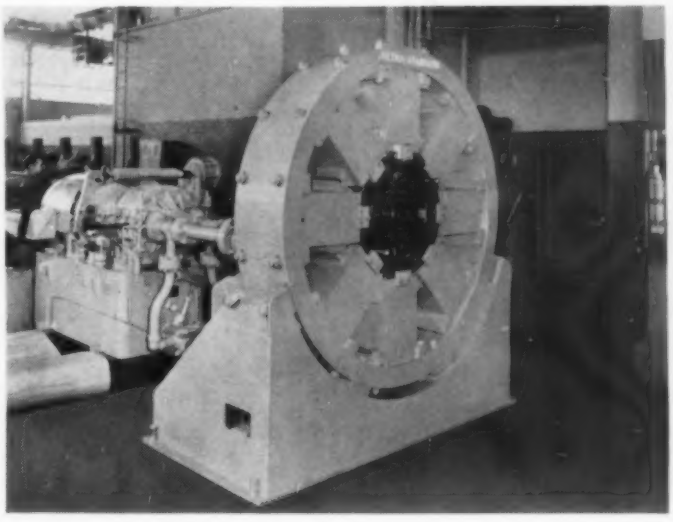
BULL BLOCK

Used for drawing long lengths of small diameter, thin wall copper tubing. Finished tube sizes—⅛" O.D. to ¾" O.D. Speeds up to 2000 f.p.m. Block diameters—10" to 60"; Block lengths—24" to 72". Pulling capacities—1000 to 20,000 lbs. Inverted or Horizontal types.



BAR BENCH

Continuous flow material line from Bench to Shear to Straightener. Used for single, double or triple draw—rounds, squares, hexagons, flats, shapes in ferrous or non-ferrous (mild steel, stainless and alloys). Pulling capacity 25,000 to 100,000 lbs. Draw lengths 20 to 60 ft. lg. Choice of arms. Used with or without push pointers.



SQUEEZE POINTER

New hydraulic power unit. Simplified design, oil-tight, electric timers. Used for pointing copper, brass, and aluminum tubes, sizes 3" O.D. to 13" O.D. Automatic and manual control. Stroke adjustment for various point sizes. Production—Approximately 150 points per hour on 3" O.D. Copper Tube pointed to 1½" dia.

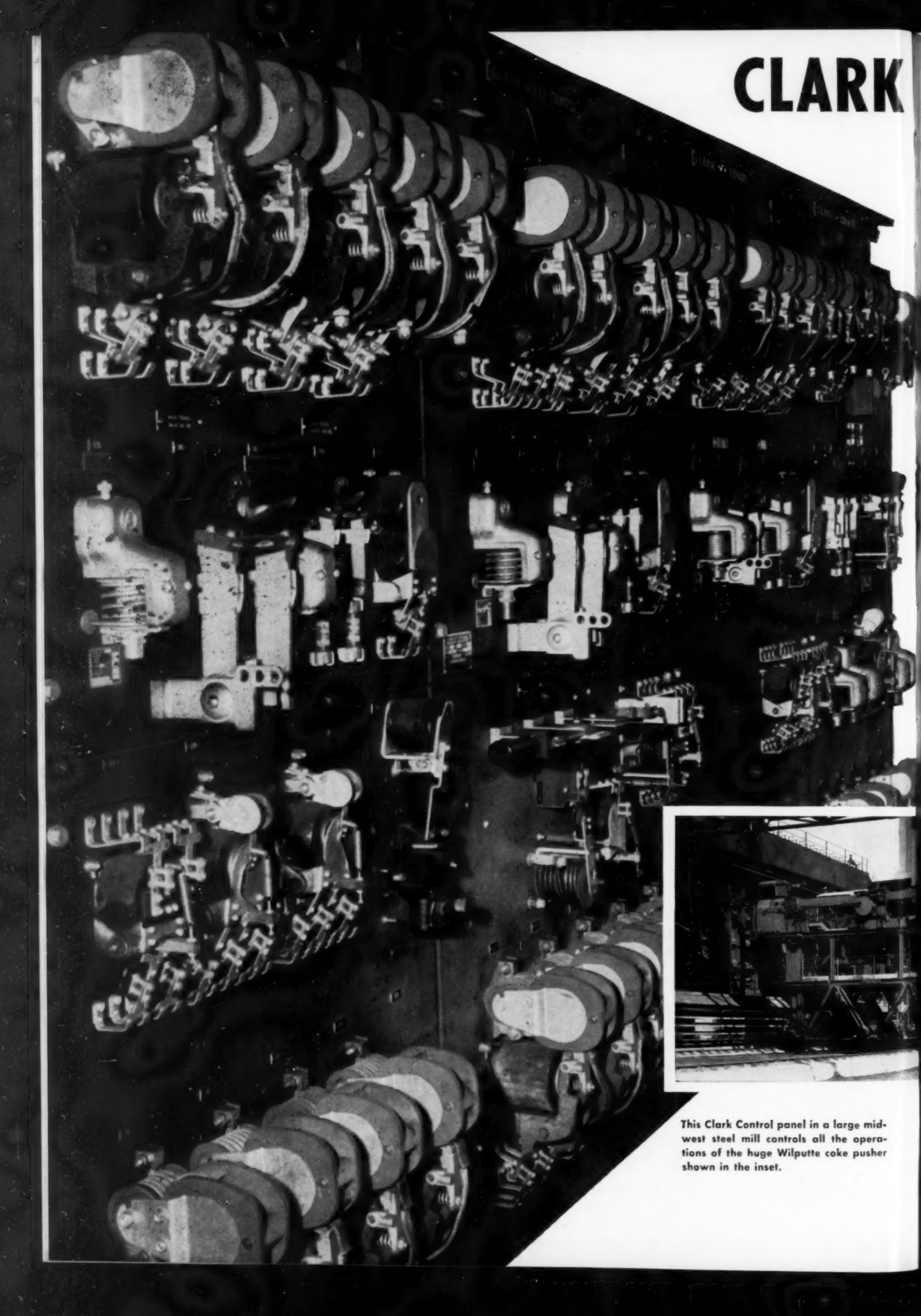
AETNA • STANDARD

THE AETNA-STANDARD ENGINEERING COMPANY

GENERAL OFFICES: PITTSBURGH, PA. **PLANTS: ELLWOOD CITY, PA., WARREN, OHIO**

CONTINUOUS GALVANIZING LINES • CONTINUOUS ELECTROLYTIC TINNING LINES • SIDE TRIMMING AND SHEAR LINES AND OTHER FINISHING EQUIPMENT • CONTINUOUS BUTT WELD PIPE MILLS • SEAMLESS TUBE MILLS • DRAWBENCHES AND OTHER COLD DRAW EQUIPMENT • ROLLS AND CASTINGS • EXTRUDERS, MILLS, PRESSES FOR RUBBER AND PLASTIC

CLARK b



This Clark Control panel in a large mid-west steel mill controls all the operations of the huge Wilputte coke pusher shown in the inset.

backs dependability of VARI-TIME® principle with LIFETIME GUARANTEE...

Clark Vari-Time contactors with built-in adjustable time delay are the heart of Clark DC control for heavy-duty applications. They are particularly suited to the rugged service demanded of steel-mill control equipment.

The timing element or core in Vari-Time contactors is a hermetically-sealed unit that *never requires maintenance or repair.* It has been so successfully trouble-free on thousands of installations over the past 30 years that we do not hesitate to reaffirm this original guarantee:

"The Clark Controller Company will replace free of charge any Vari-Time Core which will fail in service during the life of the controller."

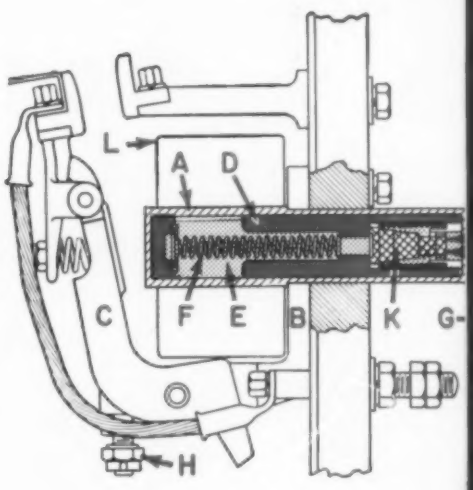
Since the time delay unit is an integral built-in component of Vari-Time contactors, the need for accelerating relays is eliminated. This substantially reduces the amount of panel wiring. There are no timing relays that require maintenance. Stocking of repair parts is simplified because all wearing parts for both main and accelerating contactors are duplicates.

Let a Clark Application Engineer show you how the Clark "Vari-Time" principle can provide greater dependability and reduced maintenance on your D.C. control.

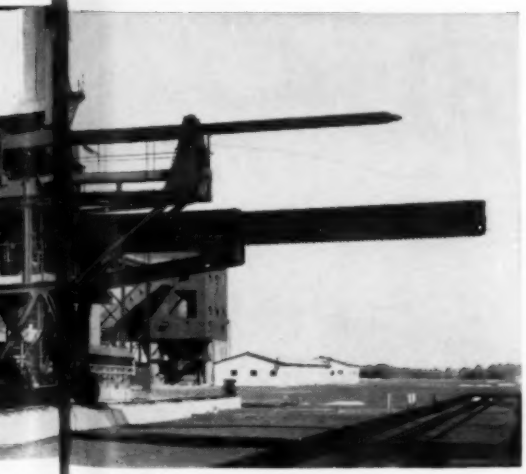
CLARK BULLETIN 7400
TYPE RT VARI-TIME CONTACTOR.

HERE'S HOW IT WORKS

This drawing shows a cross-section of a Vari-Time contactor in de-energized position. When coil "L" is energized, a magnetic flux is set up through brass cylinder "A", steel frame "B" and steel armature "C". Since brass cylinder "A" is non-magnetic, the armature "C" does not close main contacts until the steel plunger "D" is pulled forward into the center of the coil. Liquid "E" retards this motion as it passes through orifice "G"



Time delay is provided by this action. Valve "K" is designed to compensate for variations in voltage by controlling the size of orifice "G" to maintain uniform timing.



As steel plunger "D" nears the center of coil "L", build-up of flux causes armature "C" to close the main contacts. Steel plunger "D" stays at the front of brass cylinder "A" as long as coil "L" is energized.

Armature "C" immediately drops open when coil "L" is de-energized. The design of valve "K" permits free flow of liquid "E" on the return stroke, and spring "F" snaps plunger "D" back instantly. 3 to 1 timing adjustment is provided by adjustable stop "H".

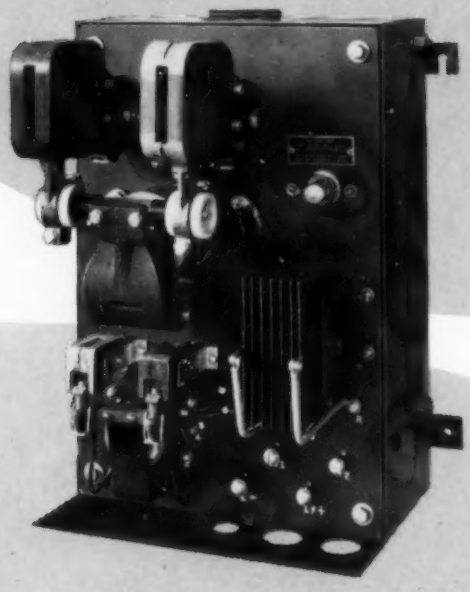
The CLARK CONTROLLER *Company*

Everything Under Control

1146 East 152nd Street • • Cleveland 10, Ohio

IN CANADA: CANADIAN CONTROLLERS, LIMITED • MAIN OFFICES AND PLANT, TORONTO

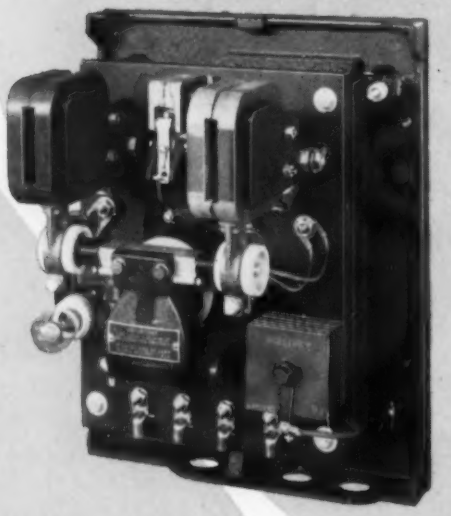
Ohio RD2 Controller (case not shown)



for better performance
it's Ohio Magnets—
especially when used with

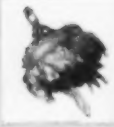
OHIO MAGNET CONTROLLERS

Ohio RD1 Controller (case not shown)



Size for size, Ohio Magnets lift larger loads over longer periods—*particularly when used with Ohio Magnet Controllers.* For Ohio Magnet Controllers are of the high-efficiency, instantaneous-discharge type for any standard or special line voltage from 36 to 250 volts DC. Specify Ohio RD1 Controllers for 35-100 amps, Ohio RD2 Controllers for 75-150 amps—and get better magnet performance. Check Yellow Pages for your nearest Ohio Electric representative or contact Ohio plant for full information.

AA-2968



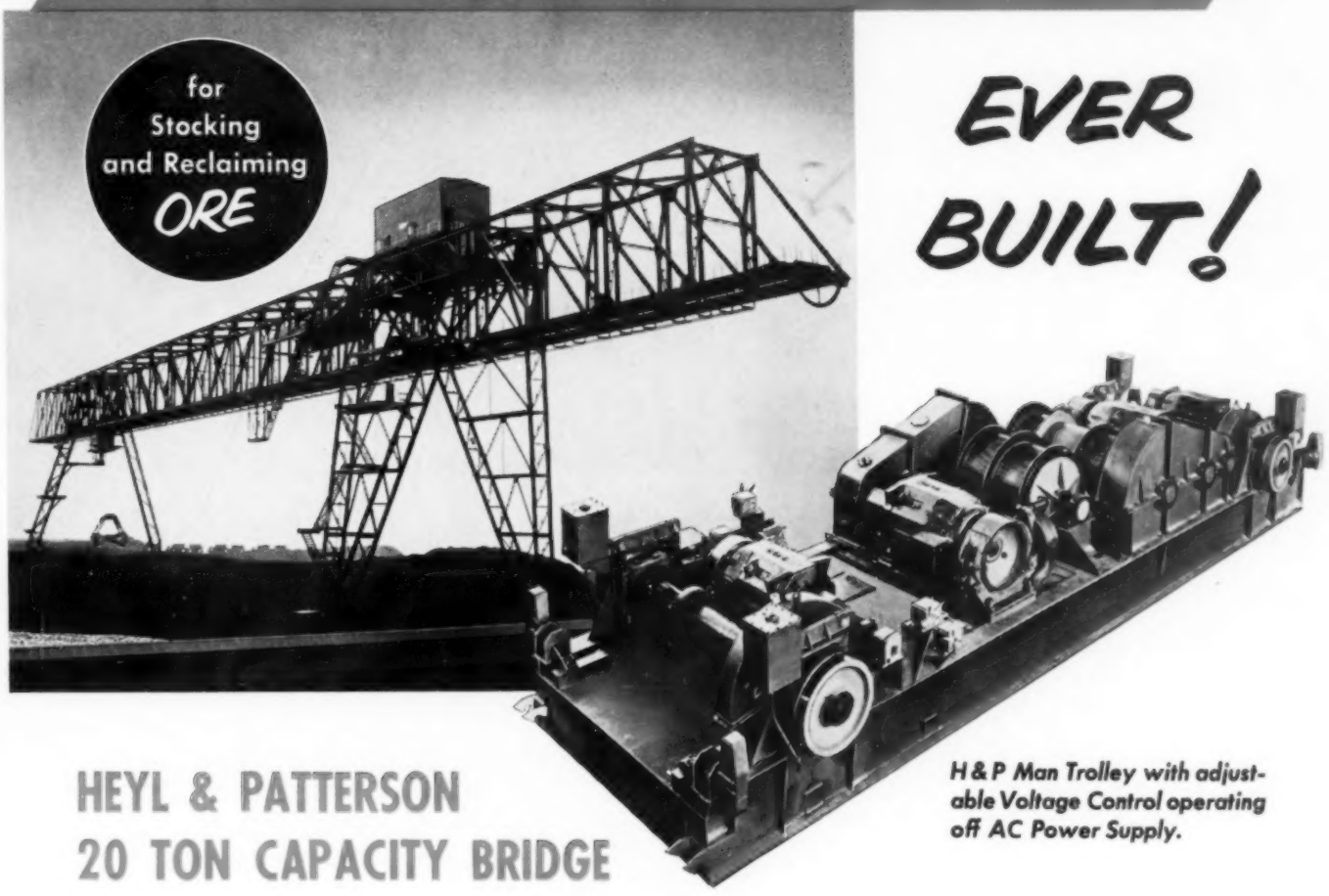
ohio ELECTRIC

Chester Bland
President

THE OHIO ELECTRIC MFG. CO.
5400 Dunham Road • Maple Heights • Cleveland, Ohio

Ohio Also Makes Separation Magnets
Nail Making Machines • Fractional
Horsepower, Shell and Torque Motors

One of the most modern bridges...



EVER BUILT!

H & P Man Trolley with adjustable Voltage Control operating off AC Power Supply.

HEYL & PATTERSON 20 TON CAPACITY BRIDGE

Half-a-century of performance records prove that Heyl & Patterson Ore and Coal Bridges are designed, built and erected for dependable and long-lasting performance. Bridges similar to the one shown here for stocking and reclaiming ore, are designed in cooperation with the engineers of many Steel Companies, to function economically and safely with an important object in mind . . . reduction of structural, mechanical and electrical maintenance.

TAKE A GOOD LOOK AT THIS BRIDGE. Then ask a Heyl & Patterson Sales-Engineer to demonstrate how its many features can reduce to a minimum the cost of your operating budget.

H & P FEATURES WORTHY OF YOUR CONSIDERATION . . . Wide Flange Beam Construction to reduce rust corrosion . . . Adjustable Voltage Control for smooth trolley operation, for increased hoisting speed and reduction of trolley weight . . . Aluminum Contact Conductors . . . Fabreeka Mountings for shock absorption . . . Worm Gear Driven Trucks . . . Hydraulically Operated Automatic Rail Clamps . . . Trolley Buffers. These are some of the features justifying the headline . . . "One of the Most Modern Bridges Ever Built."

Heyl & Patterson
INC.

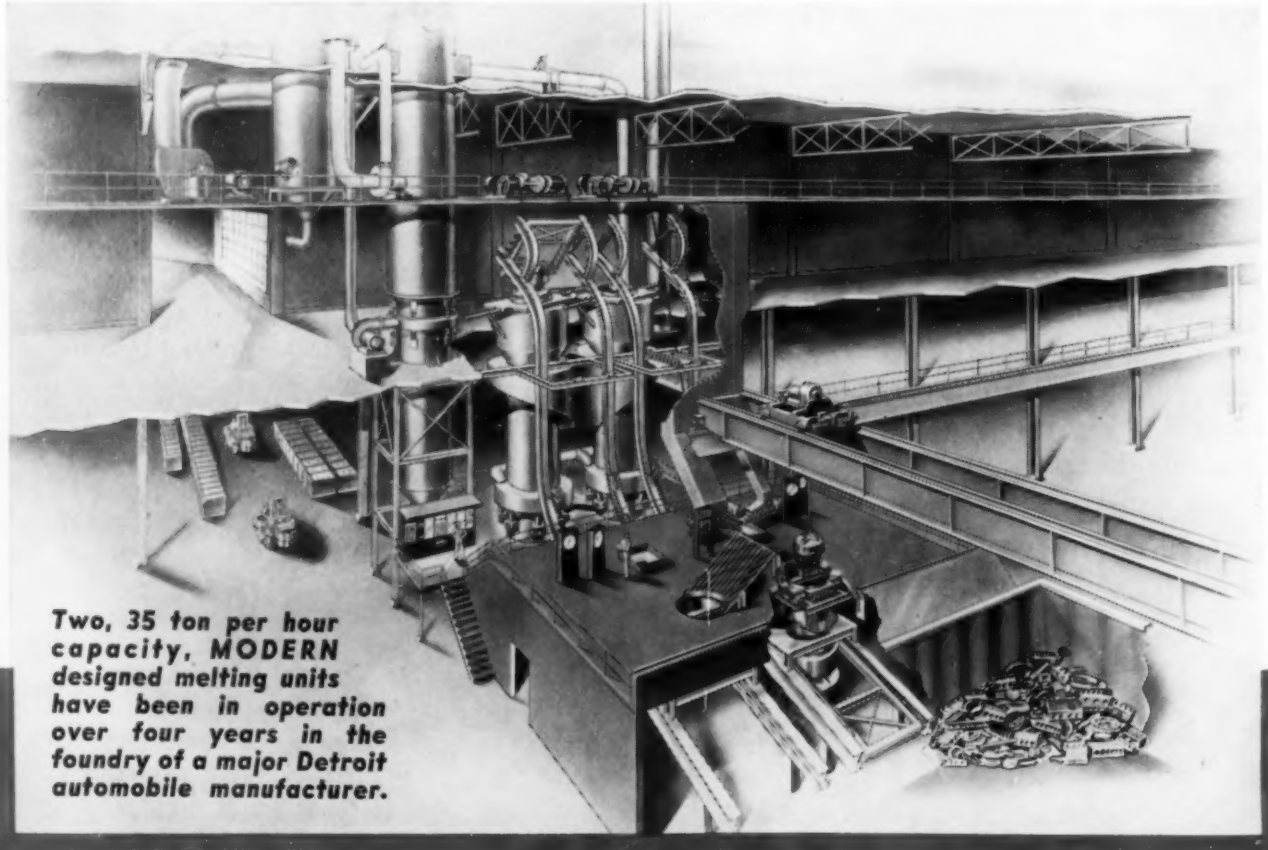
BULK MATERIALS HANDLING EQUIPMENT ALL THE WAY FROM DESIGN TO ERECTION

55 FORT PITT BLVD. • PITTSBURGH 22, PA. • Phone COurt 1-0750

Announcing!

A new, economical source of HOT METAL SUPPLY FOR YOUR MELTING SHOP!

HOT METAL from LOW COST, unprepared scrap for your open hearths, electric furnaces or a new, top-blown oxygen converter is now available. Installation of a MODERN compact and complete cupola melting system in your present plant will increase capacity 30 to 40 tons an hour.

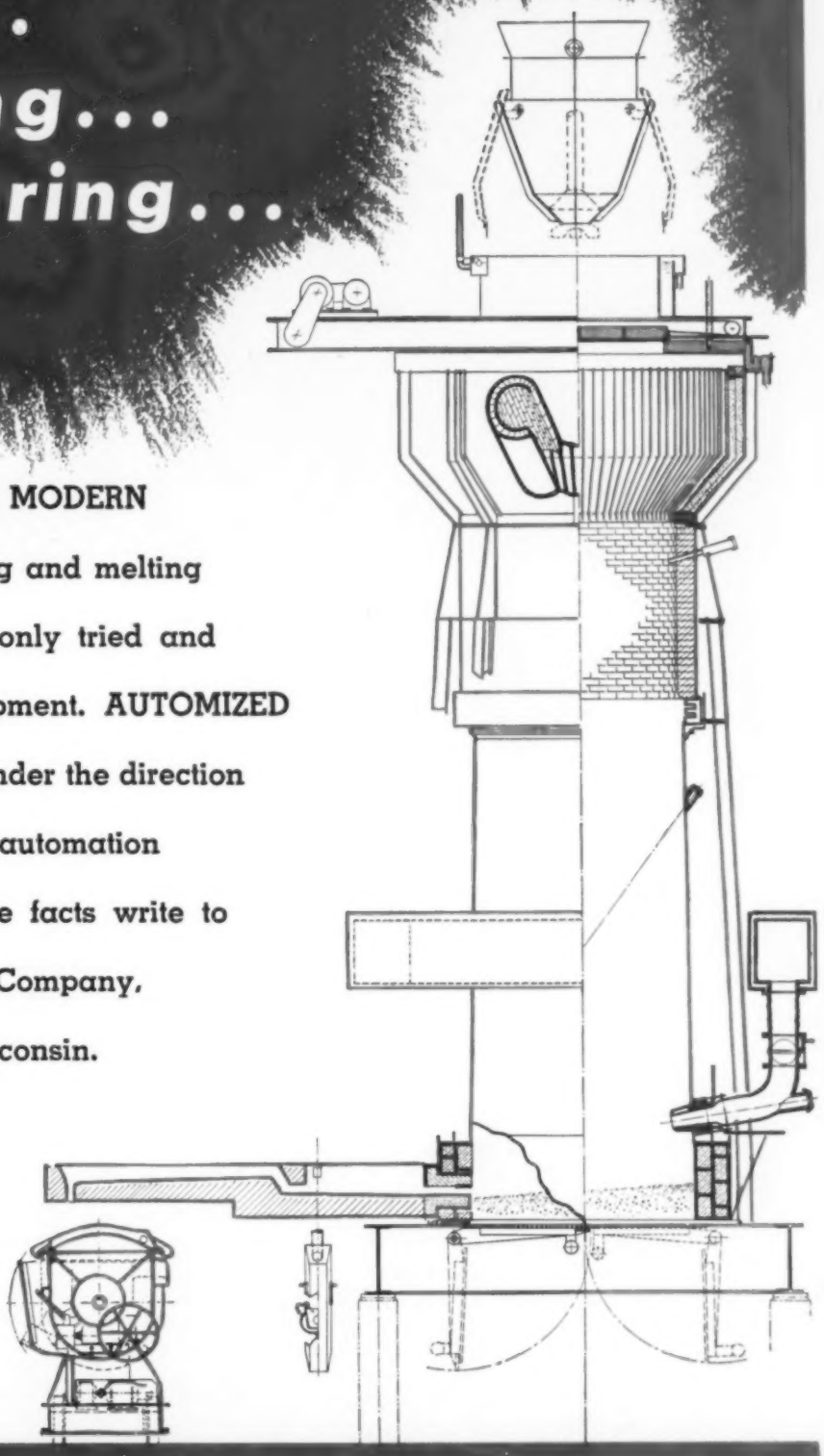


Two, 35 ton per hour capacity, MODERN designed melting units have been in operation over four years in the foundry of a major Detroit automobile manufacturer.

35 YEARS SUCCESSFUL

planning... engineering... manufacturing... erection!

all are reflected in a MODERN ENGINEERED charging and melting system incorporating only tried and proved auxiliary equipment. AUTOMIZED controls are applied under the direction of America's foremost automation engineers: For all the facts write to MODERN Equipment Company, Port Washington, Wisconsin.

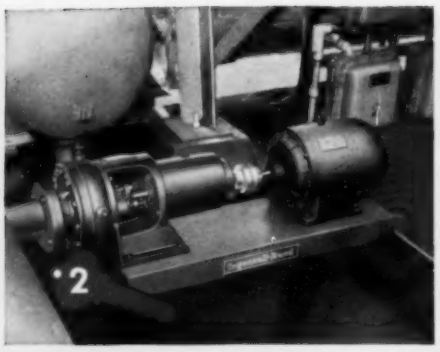


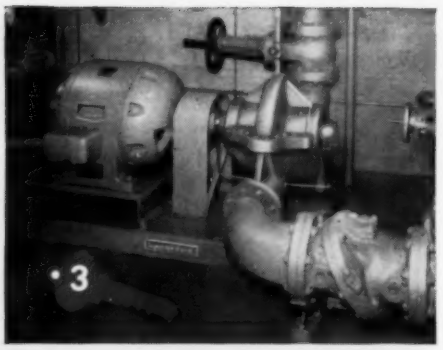
MODERN, externally water-cooled cupola.

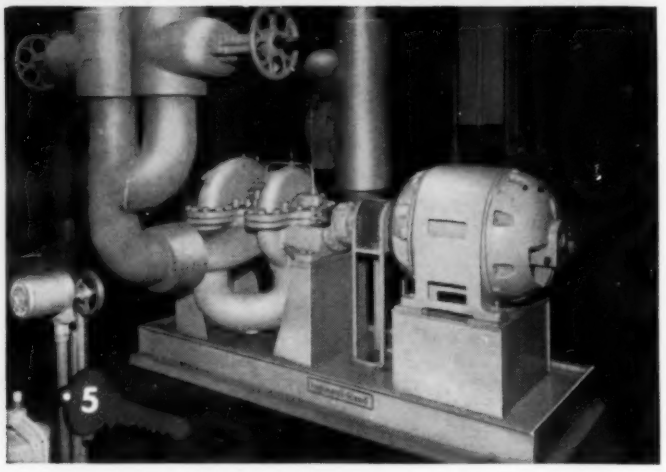
MODERN

MODERN EQUIPMENT COMPANY
Port Washington, Wisconsin

Complete cupola melting and charging equipment with recuperative hot blast and dust emission cleaning systems.







Five Keys to LONG-RANGE ECONOMY on your general-purpose pumping jobs

The Ingersoll-Rand pumps shown feature several different designs and types. Yet they all have one thing in common—the ability to give you low-cost performance on your general purpose pumping jobs.

When you install an I-R pump, you can count on continued efficient operation—with a minimum of time out for attention and maintenance.

In addition to the pumps shown, Ingersoll-Rand manufactures a complete line of single and multi-stage pumps of horizontal and vertical design for every job application. See your I-R representative for full information on the pump which best meets your needs.

1. MOTORPUMPS: Free from base plates, couplings and alignment problems, I-R Motorpumps can be mounted in any position that gives the simplest, most economical installation. They are especially designed for continuous full load service, with a wide range of capacities from 5 to 1800 gpm and heads up to 600 ft. Available in single, two and four-stage units.

2. CRADLE-MOUNTED PUMPS: Built with separate pump and drive units, coupled and mounted on a sturdy base plate, I-R Cradle-Mounted Pumps come in one and two stages, with capacities from 5 to 2800 gpm and heads up to 525 ft. They can be equipped with any drive, and provide easier accessibility, over-sized bearings and greater accessibility.

3. SINGLE-STAGE HORIZONTALLY-SPLIT PUMPS, with double mechanical shaft seals: For capacities from 275 to 2400 gpm and heads to 350 ft., maintenance-free DMV and DHV pumps are provided with double mechanical shaft-seals and permanently lubricated sealed bearings. Troublesome stuffing box maintenance is eliminated, and bearings do not require any attention or lubrication throughout the life of the pump.

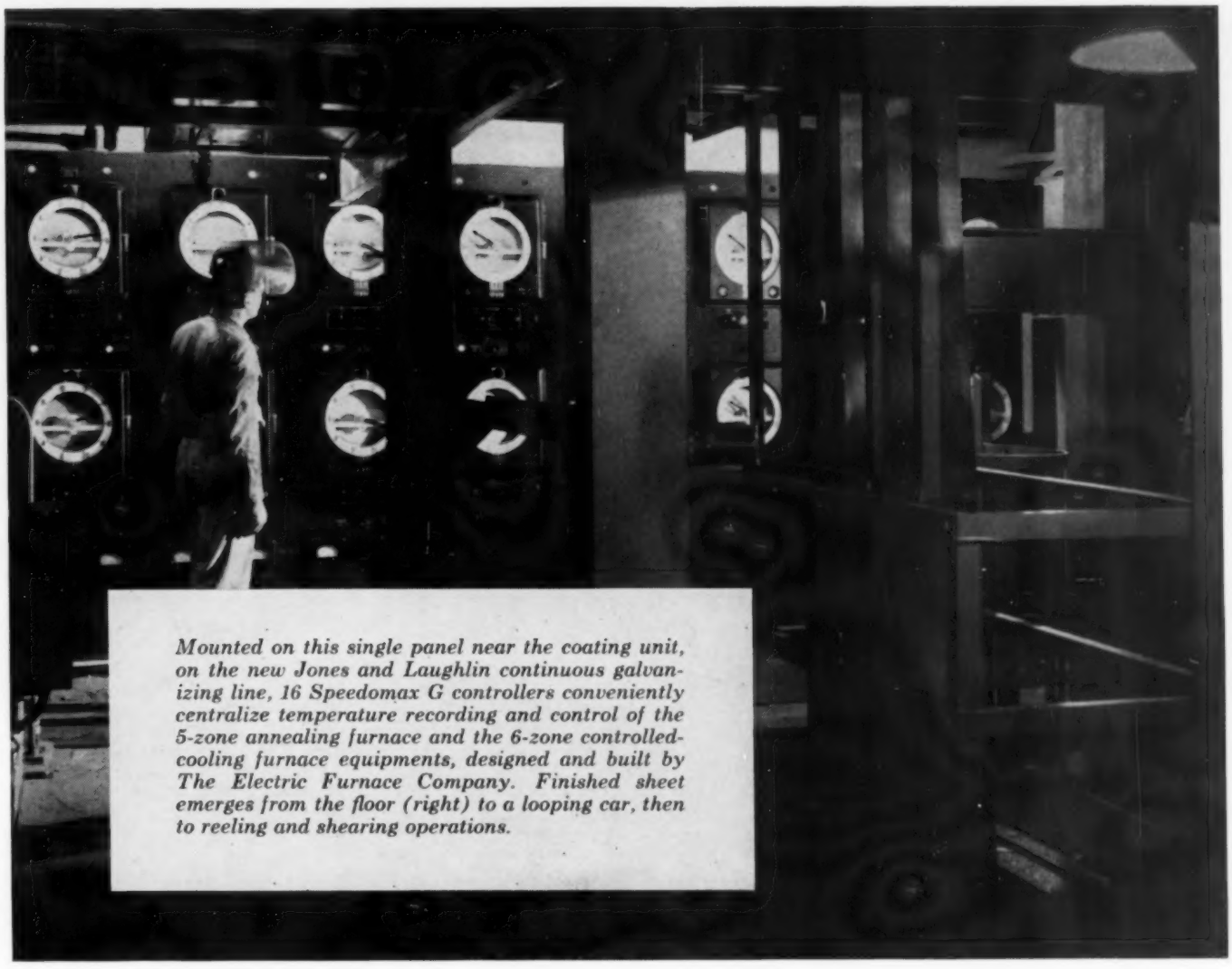
4. SINGLE-STAGE HORIZONTALLY-SPLIT PUMPS, conventional design: The Class AFV unit illustrated is typical of the standard I-R line of single-stage horizontally-split centrifugals, with capacities ranging from 25 to 50,000 gpm, and heads from 20 to 350 ft. Stuffing boxes are extra deep, and equipped with water seal cages. Any type of drive may be used.

5. TWO-STAGE HORIZONTALLY-SPLIT PUMPS: I-R two-stage Class GT pumps are available in capacities up to 2200 gpm for discharge heads up to 1050 ft. Outstanding performance is assured by such features as extra deep stuffing boxes, renewable shaft sleeves and wearing rings, carefully designed liquid passages and volutes, and efficient closed-type impellers.

Ingersoll-Rand

10-455 **11 Broadway, New York 4, N. Y.**

PUMPS • ROCK DRILLS • GAS & DIESEL ENGINES
COMPRESSORS • CONDENSERS • AIR & ELECTRIC TOOLS



Mounted on this single panel near the coating unit, on the new Jones and Laughlin continuous galvanizing line, 16 Speedomax G controllers conveniently centralize temperature recording and control of the 5-zone annealing furnace and the 6-zone controlled-cooling furnace equipments, designed and built by The Electric Furnace Company. Finished sheet emerges from the floor (right) to a looping car, then to reeling and shearing operations.

'Round-the-clock Quality Control for a Galvanized Sheet 13 weeks long

With a maintenance schedule calling for only 4 shut-downs per year, the new, 610-foot continuous galvanizing line at the Pittsburgh Works of Jones & Laughlin Steel Corporation is geared for 'round-the-clock production at a high rate. Capacity is 7000 to 8000 tons of sheet per month, in an extensive range of widths, gages and coatings—and the booming market for this product demands peak operation.

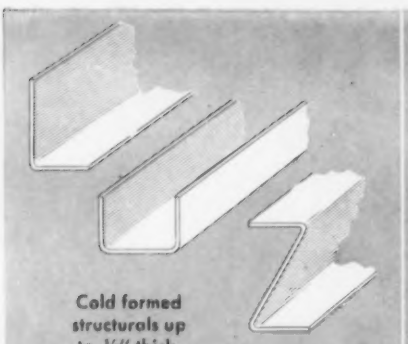
For such day-in, day-out performance, reliable instrumentation is a "must"—consequently, more than a score of Speedomax recorders and controllers bear a critical responsibility for quality of product.

Sixteen Speedomax G controllers regulate temperature in the controlled-atmosphere annealing and cooling furnaces, for in-line treatment of the sheet prior to coating. Other Speedomax G and Speedomax H instruments record or control temperature of the sheet itself, the melt, the chemical treating bath, and the ammonia dissociators.

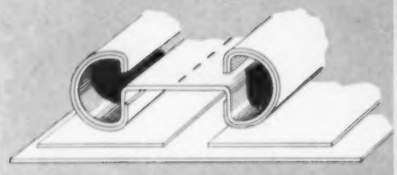
With an increasing trend toward continuous processing, the quality and dependability of L&N instruments become steadily more important to those who want to assure top return from a major plant investment.

If *you're* planning expansion or modernization, call in an L&N engineer at the early stages—and draw on extensive experience in steel industry instrumentation to guide your thinking. Simply contact our nearest office, or write us at 4942 Stenton Avenue, Philadelphia 44, Pa.

LEEDS Instruments LN NORTHRUP Automatic Controls • Furnaces



Cold formed structurals up to ½" thick.

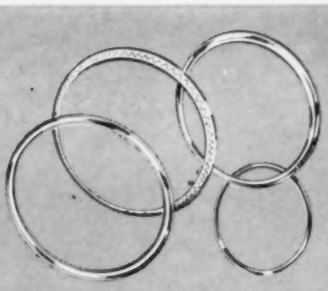


Two or three strips of different materials combined and slit into two identical or different shapes.

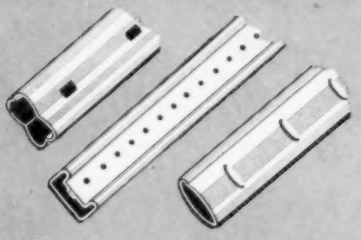
Raceway conduit mouldings by Wiremold Co., Hartford, Conn.

Cold Roll Formed curved ribs and other structurals used in airplanes, metal buildings, etc.

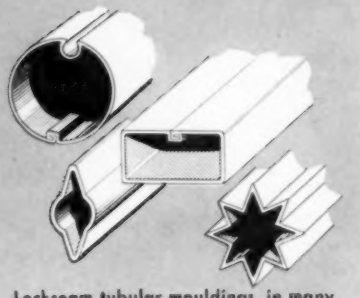
Metal awnings, rolling doors, etc., made from interlocking roll formed slats.



Rings of any size, for a multitude of different uses.



Roll-formed shapes, notched, perforated, indented or embossed.



Lockseam tubular mouldings, in many styles and shapes.

1001 Things Now Being Done By COLD ROLL FORMING

• The basic function of a Yoder cold roll forming machine is, of course, to convert flat rolled strip or sheets at high speed into mouldings, panels, tubular, channel and other shapes.

Quite often, these shapes need further elaboration before being ready for assembly or installation. They may, for instance, have to be curved, coiled or made into rings. Or they may need to be perforated at certain intervals of spacing, notched, embossed, or otherwise finished by additional operations. You may want to combine two or more materials into a finished shape, such as carbon steel with stainless, felt, wood, etc.

These and many other things can be done with Yoder machines at little or no extra cost over and above normal conversion costs, simply by providing special attachments, or by auxiliary units installed in line with the forming mill.

So, to the recognized high economy of the cold forming operation itself, other important production economies may be added. Yoder engineers are at your service in designing equipment of this kind.

The Yoder Book on Cold Roll Forming is a complete text, profusely illustrated, on the art and its scope, the machines, their tooling and application to a multiplicity of mass production needs. A copy is yours for the asking.

THE YODER COMPANY • 5495 Walworth Ave., Cleveland 2, Ohio

ENGINEERING YODER MANUFACTURING

COLD ROLL FORMING MACHINES

ROTARY SLITTING LINES

PIPE AND TUBE MILLS—Electric Weld

FIFTH OF A SERIES

Customer's Report

"No other type of furnace can approach the high load factor of single stack annealing"

In plants where single stack furnaces have been installed and where multiple stack equipment was previously used, the universal comment is, "Our load factor in the Lee Wilson single stack furnace is higher than we ever thought possible in any type of furnace equipment."

Theoretically, for a given tonnage, the same number of coils of various sizes must be loaded on the pedestals, and it is contended that the load factor must be the same for all furnaces. However, when four to eight times as many coils have to be used to make up a charge, it is just not possible to arrive at the same number of average tons per pedestal as it is for single stack furnaces.

Our customers' reports on this matter from many sources all agree that no other type of furnace can approach the high load factor of single stack annealers!

Only Lee Wilson Furnaces Give You All These Advantages

1. GREATER FLEXIBILITY
2. MORE UNIFORM HEAT APPLICATION
3. IMPROVED CUSTOMER SERVICE
4. HIGHER PRODUCTION
5. BETTER LOAD FACTOR
6. MINIMUM PROCESS INVENTORY
7. REDUCED LABOR COST
8. BETTER OPERATING CONDITIONS
9. LOWER MAINTENANCE COST
10. REDUCED INSTALLATION COSTS

Lee Wilson* ENGINEERING COMPANY, INC.

20005 WEST LAKE ROAD • CLEVELAND 16, OHIO

SINGLE-STACK RADIANT TUBE ANNEALING FURNACES

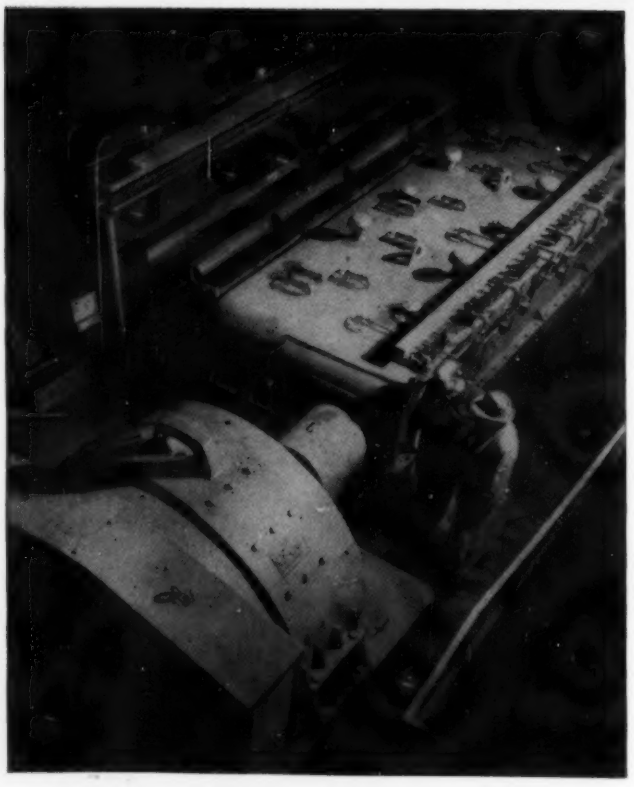
MAKE THE BEST METALS BETTER

41

* ORIGINATORS AND LEADING PRODUCERS OF SINGLE-STACK RADIANT TUBE FURNACES

The trend is to single stack. One of the nation's largest annealing departments recently put into operation 24 Lee Wilson Single Stack Furnaces and 72 bases.

Mr. H. T. Anderson, Jones & Laughlin Lubrication Engineer and Gulf Sales Engineer C. D. Gilchrist discuss lubrication of the 11-inch rod mill. Gulf E.P. Lubricants provide effective protection for the pinion stands and gear drives, while Gulf XXX Lubricant safeguards the roll neck bearings.



Finishing train pinion stands also get effective lubrication with Gulf E.P. Lubricants.

Jones & Laughlin uses the extreme pressure lubricants that provide *protection plus*...

Gulf E. P. Lubricants

Protection plus means that in addition to their extra load carrying capacity, their ability to prevent scoring and welding, Gulf E.P. Lubricants have other advantages that help Jones & Laughlin and many other steel companies get more effective lubrication and lower maintenance costs.

Gulf E.P. Lubricants have excellent water separating and rust preventive properties, exceptional stability, and effective nonfoaming and noncorrosive characteristics. And because of Gulf E.P. Lubricants' superior film strength, it is often possible to reduce the number of lubricants needed and simplify your storage and handling.

When you next order gear drive lubricants, make it an order for safe, sure protection and lower maintenance costs—specify Gulf E.P. Lubricants.

For expert help on any lubrication problem, call in a Gulf Sales Engineer. You will find him always on call. Consult the telephone directory for the number of your nearest Gulf office.

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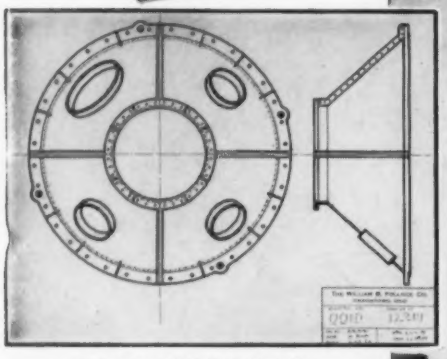
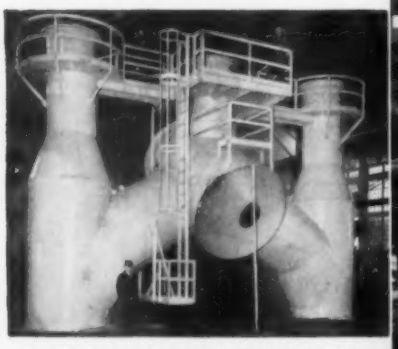
POLLOCK

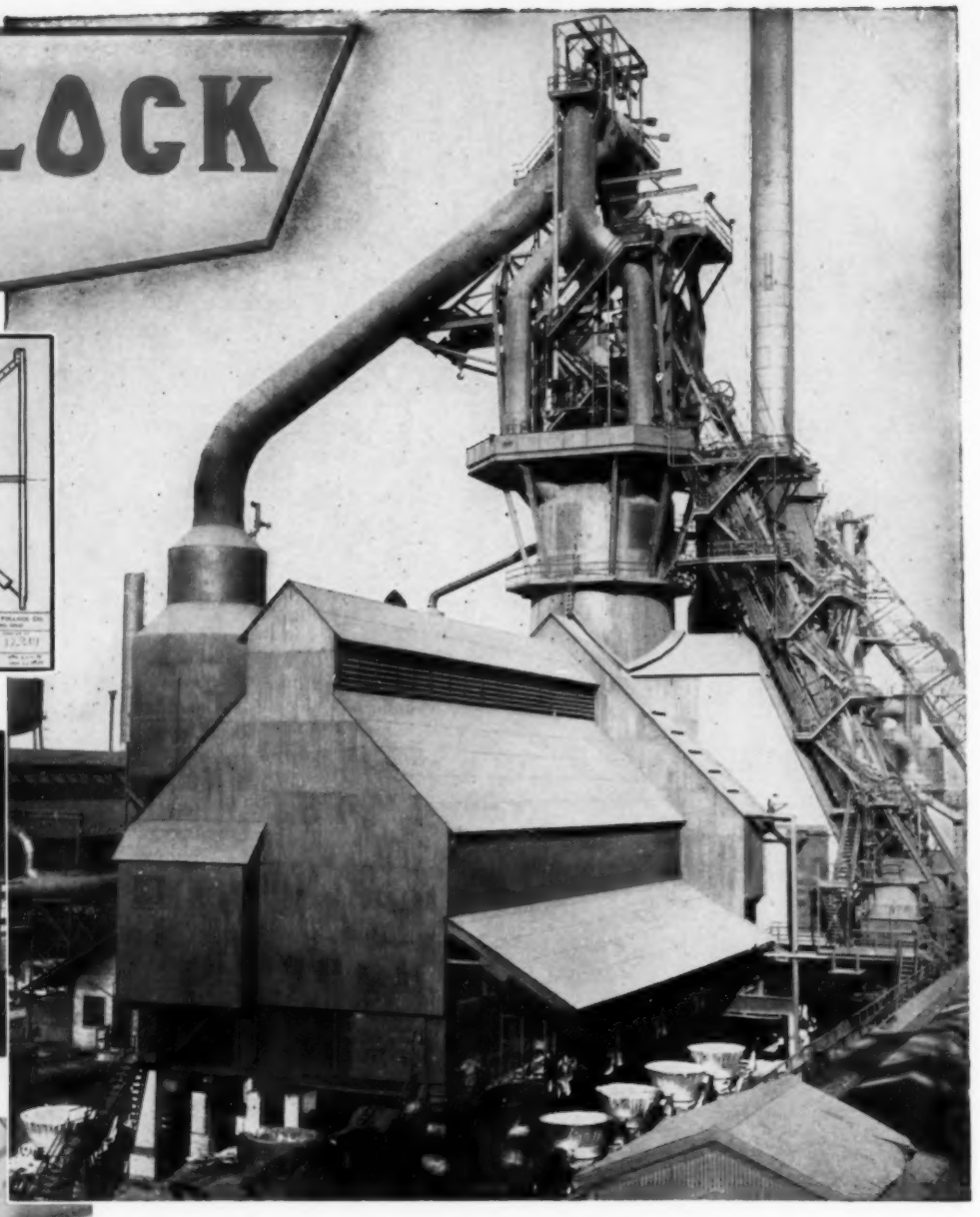


ENGINEERING



SHOP FABRICATION

FIELD ERECTION



Correlating the skills of Pollock engineering, fabrication and field erection to specific operational requirements of The Youngstown Sheet & Tube Company are evidenced in this blast furnace. In addition to furnishing the steel work for this blast furnace, Pollock designed and built auxiliary equipment, including the hot metal ladle cars and cinder cars shown in the above picture. The experience which the Pollock Company has gathered in over eighty-five years is available to you in planning your new projects.

Blast furnace STEEL WORK

POLLOCK

THE WILLIAM B. POLLOCK COMPANY
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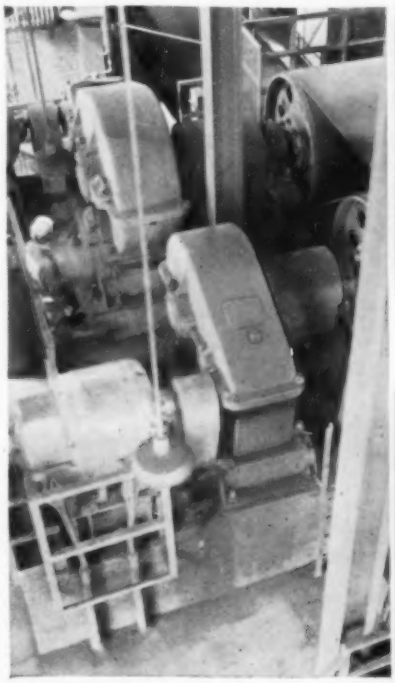
STEEL PLATE CONSTRUCTION · ENGINEERS · FABRICATORS · ERECTORS

BLAST FURNACES · HOT METAL CARS AND LADLES · CINDER AND SLAG CARS · INGOT MOULD CARS · CHARGING BOX CARS · WELDED OPEN HEARTH LADLES

Here's another complete ore handling system

designed, built, erected by LINK-BELT

Transporting iron ore to storage at 6000 tph, this 1260-ft. Link-Belt conveyor travels at 500 fpm. Series 200 impact idlers are used along 500-ft. loading area. This 60-in. wide belt also handles coal and limestone.



Power for reversible storage belt conveyor is delivered through Link-Belt parallel shaft drives.

Link-Belt traveling tripper-stacker on distributing belt conveyor stacks coal on the right, ore on the left.

This 60-in. wide Link-Belt belt conveyor is inclined 16½ degrees and delivers to screen house.

Eastern mill delegates responsibility for conveyors from docks, to and from storage, to blast furnaces

PAST experience with the efficiency of similar Link-Belt bulk materials handling systems prompted a repeat order from this eastern mill of a major steel company. Today, in mills throughout the country, Link-Belt conveyors are providing efficient, economical handling of iron ore, coal, sinter and limestone.

When you rely on Link-Belt for one-source service, we accept full responsibility for placing your system in successful operation. Link-Belt engineers will work with your consultants and engineers to give you a bulk handling system built to your exact requirements. For complete information, call your nearest Link-Belt office.

14.157

LINK-BELT

MATERIALS HANDLING, PROCESSING AND POWER TRANSMISSION MACHINERY

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

Specify... **J-M Asbestos Wick** **J-M Asbestos Rope**

Wherever you need general utility packings that are easy to handle, highly heat resistant

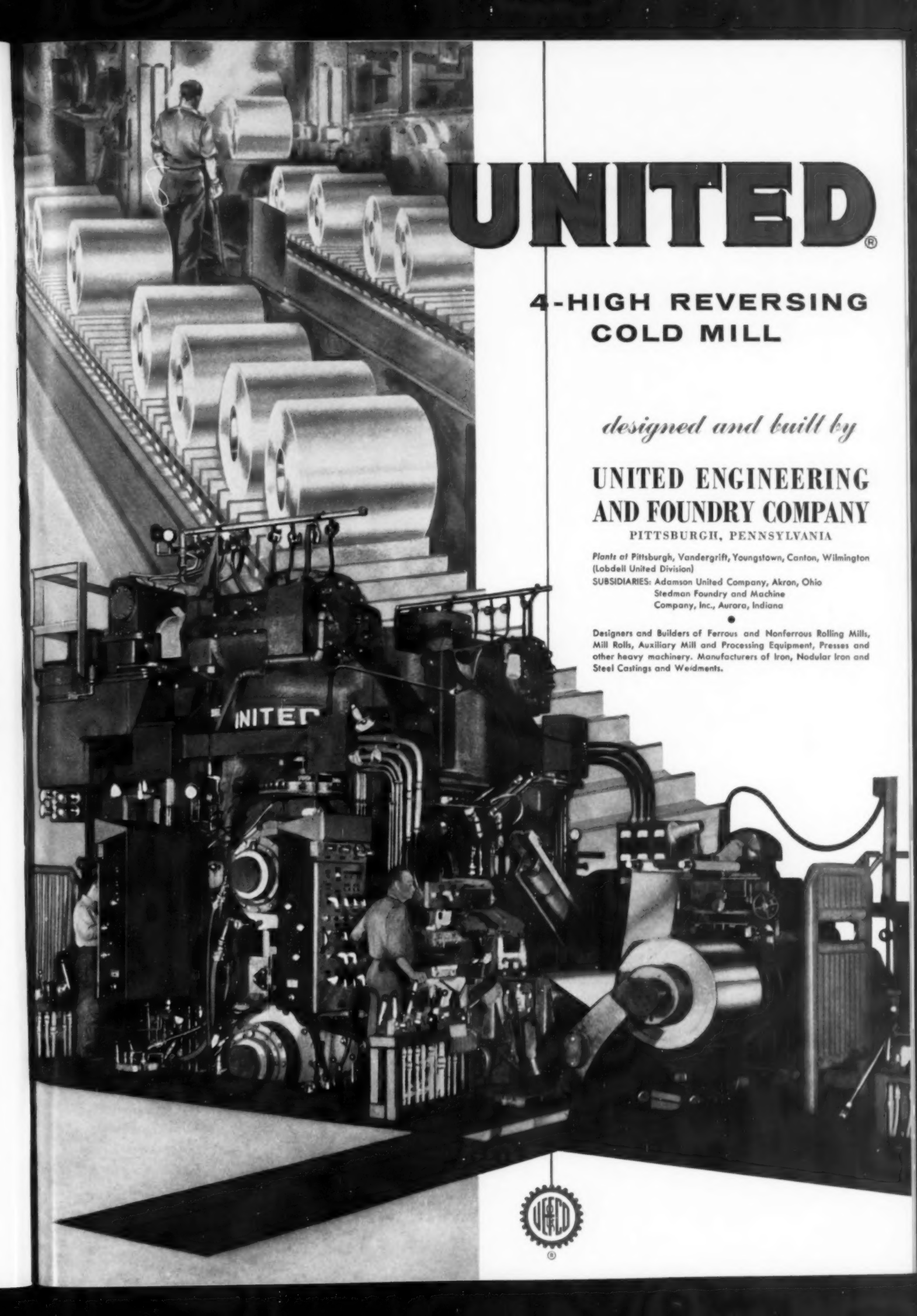
Throughout the iron and steel industries, the list of uses for Johns-Manville Asbestos Wick and Rope is constantly growing. These soft, resilient, heat-resisting materials are widely employed for general packing, gasketing and caulking applications.

In coke ovens, both are used to caulk around the doors to prevent the escape of gases. Asbestos Rope (Style 4200) also serves as expansion joint material in the brickwork.

Only a few of the many applications for Asbestos Wick (Style 4202) can be given here. It seals hot metal in the ingot mould, around the top and between the mould and the stool. It gives protection from burning to water hoses that cool Open Hearth doors. It serves as a seal between the cope and drag on moulding flasks. It is used to wipe excess coating from wires after passing through the galvanizing bath.

Styles 4200 and 4202 are made from pure asbestos fibre carefully controlled for quality at Johns-Manville's own mine and mill (largest in the world). Asbestos Rope is formed by twisting together two or more strands of Wick to obtain the desired thickness. For further information, call your local J-M distributor or write Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ontario.

Johns-Manville PACKINGS, GASKETS and TEXTILES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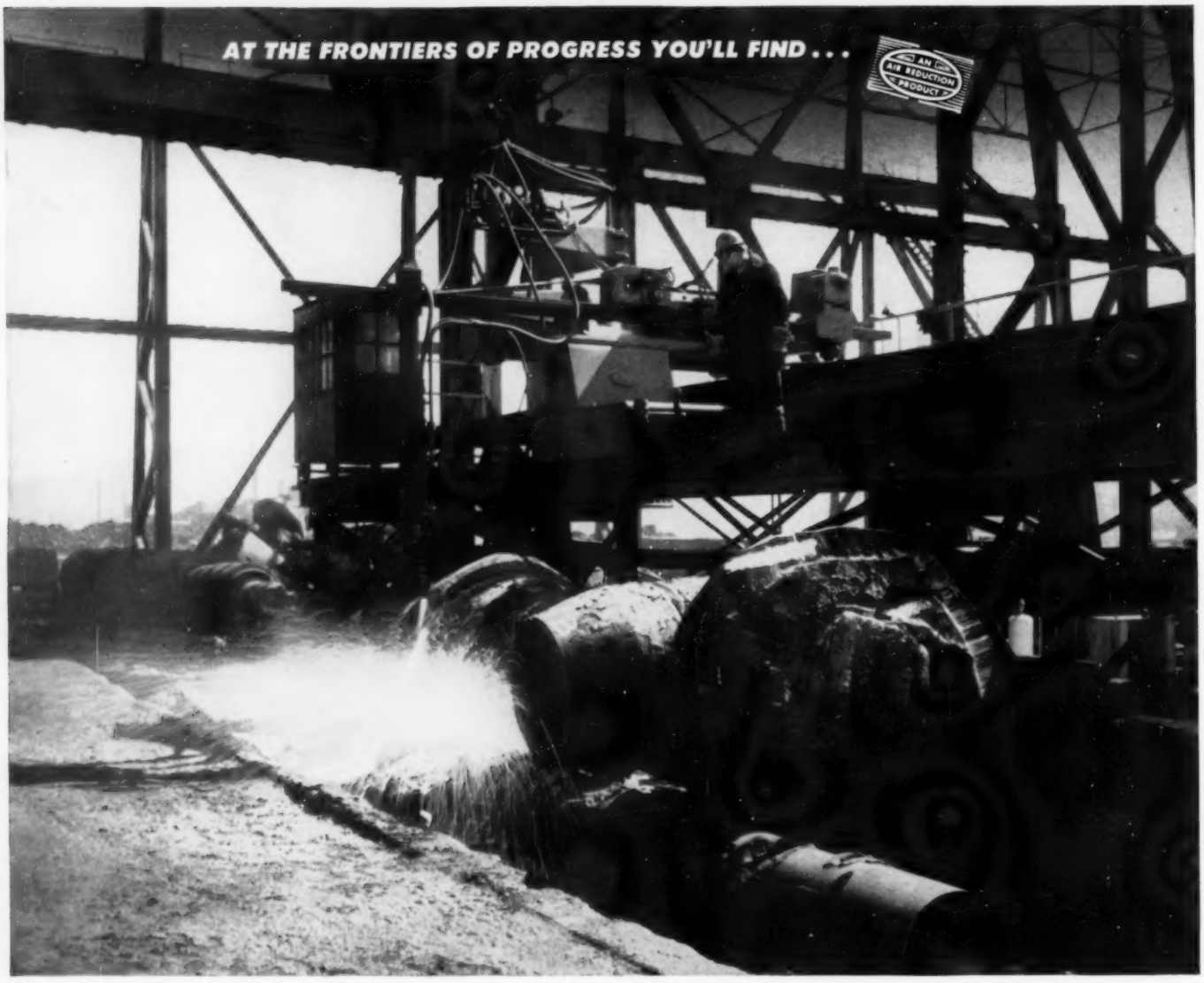

Mechanized oxygen cutting cuts heavy scrap—and costs!

Teamwork between a large eastern steel mill and Air Reduction made possible this modern mechanized oxygen cutting installation.

Heavy scrap is reduced rapidly to size for open-hearth furnaces by Airco's No. 50 Travograph equipped with heavy-duty cutting torch on elevated rails. Result: cost of steel manufacture reduced by way of saving in man hours, better scrap preparation and consequent increase of production.

Mechanized oxygen cutting is but one of the many ways in which Airco can put its special techniques to work for you. Perhaps you have a problem of either a confined work area requiring a centralized cutting operation, or a large work area that calls for mobile cutting equipment. Airco Technical Sales Representatives are ready to place their experience and knowledge at your service. Their advice and recommendations can be invaluable in improving and simplifying your production. For more information, write for Airco Bulletin ADR 97.

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Products of the divisions of Air Reduction Company, Incorporated, include: **AIRCO** — industrial gases, welding and cutting equipment, and acetylenic chemicals • **PURECO** — carbon dioxide, liquid-solid ("DRY-ICE") • **OHIO** — medical gases and hospital equipment • **NATIONAL CARBIDE** — pipeline acetylene and calcium carbide • **COLTON** — polyvinyl acetates, alcohols, and other synthetic resins.

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Open Hearth and Electric Steel Furnaces

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MAGNESIA RAMMING MIXTURES

H-W C MIX

Made From High Purity Seawater Periclase (92% Magnesia)

- **STABLE**—Excellent Volume Stability (shrinkage less than 1% when heated to 2910 F—ASTM C-113-46).
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- **DENSE**—High density—low permeability.
- **EASY TO USE**—Cold rammed to finished contour of any hearth.
- **ECONOMICAL**—Provides durable monolithic hearths with low installation cost and increases furnace availability.

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Made From Dead-Burned Washington Magnesite—Specially Sized—(80% Magnesia)

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keeps veteran mill rolling

Before starting up in the fall of 1936, this rolling mill was equipped with a Trabon Centralized Lubrication System, shown in red.

Each bearing has received measured amounts of grease at the correct time, day in and day out, for these twenty years. Because lubrication has been automatically performed by a Centralized Trabon System, bearing failure has been virtually non-existent.

How is your equipment lubricated? Only a Trabon System can bring you all these advantages:

1. **Save dollars. The number of man hours saved in a few months will pay for a Trabon System.**
2. **Reduce down time. A Trabon System lubricates while the machine is running with no hazard to the operator.**
3. **Positive check on lubrication. A Trabon System automatically indicates any stoppage of lubrication and provides a simple method of tracing the trouble.**
4. **Extend machine life. A Trabon System lubricates every point correctly, eliminating burned out bearings due to improper lubrication.**

In the Trabon line of oil and grease systems you will find a system that exactly suits your equipment. May we send you some literature on the subject?

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1814 E. 40th STREET • CLEVELAND 3, OHIO
Oil and Grease Systems

By MELVIN NORD, Patent Attorney, Detroit, Mich.

Patent Reviews

. . . . copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents . . . . patents reviewed cover period May 29, 1956 through June 26, 1956 . . . .

APPARATUS FOR QUENCHING AND REELING RODS

▲ U.S. 2,747,587, issued May 29, 1956 to Alexander W. Strachan and assigned to United States Steel Corp., describes an apparatus for quenching and reeling hot rolled rods which avoids excessive stiffness of the rod, and thus avoids its bunching together into a mass of twisted scrap on the reel mechanism.

As shown in Figure 1, rod R passes through the last roll stand 2 into the bell mouth 4 of a guide pipe 6 and then into a bell mouth 8 leading into the water cooler box 10. The water quenching is accomplished in a number of sectional elements 12 within the box 10. As shown in Figures 2 and 3, each element consists of concentric tubes 14 and 16 having a space 18 between them. The inner tube contains holes 20 drilled at an angle of 45 degrees to allow water to enter the inner portion 22 of the pipe 14, through which the rod R travels. Water is delivered to the space 18 from a header 24 through branch pipes 26. Water flow to the header is automatically controlled by a solenoid 34, which is actuated by a contactor 36 which is in turn operated by an electric eye 38. A polished reflector 40 is located on the opposite side of the pass line from the electric eye.

When the rod passes under the electric eye, it operates contactor 36 which energizes solenoid 34 opening the quick acting valve 32. This starts water flowing into the header. The speed of the incoming rod is so great that by the time the rod begins to be quenched with water, 25 to 65 ft of rod have passed through the quenching apparatus and will have therefore readily wrapped itself about the pins 52 of the reeler thus eliminating bunching or cobbling. Once the rod is securely wrapped around the pins of the reel, the quenched rod will follow without damage.

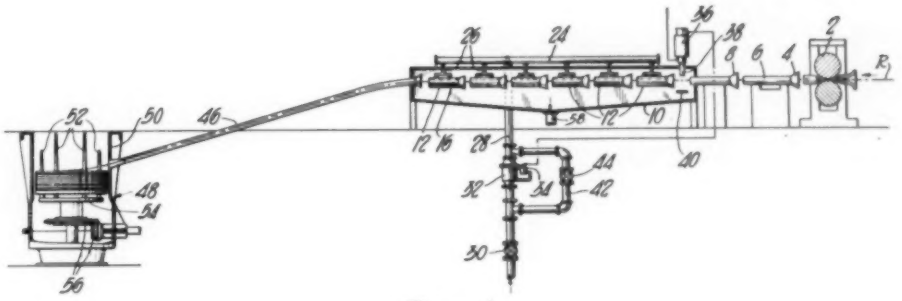


Figure 1

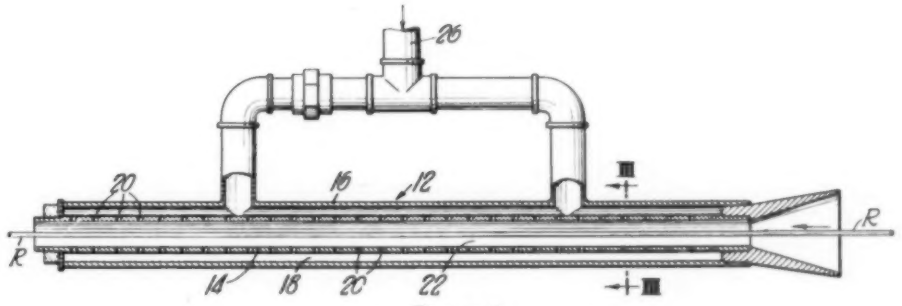


Figure 2

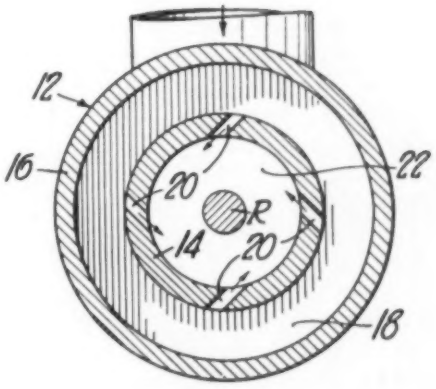


Figure 3

DIRECT PRODUCTION OF COMMERCIALLY PURE IRON

U.S. 2,747,985, issued May 29, 1956 to Vincenzo S. Arata, describes a process for producing commercially pure iron from iron ore in an electric furnace.

The iron ore, preferably in the form of powdered magnetite, is mixed with finely divided charcoal rather than with coke, and in an amount

insufficient to reduce all the oxygen present in the ore, i.e. enough to leave about 0.06 per cent carbon in the iron produced. Limestone is also added as a flux, and the mixture is charged to an electric furnace having a basic lining. When the batch has become liquid, the slag formed is removed and the batch is checked to make sure that the carbon and sulphur contents are each below 0.06 per cent. Additional amounts of limestone and magnetite may be added as required.

The addition of limestone and magnetite is continued and the slag continuously removed until the test samples not only can be bent 180 degrees without cracking, but also show a silvery color at the edge. The most convenient temperature for casting is reached when a test sample poured on a steel plate presents a slight adherence.

The batch may be killed by adding aluminum to the ladle. The killed iron is then cast in ingot molds lined with asbestos, so as to avoid microscopic fissures in the ingots.

Unlike "sponge iron," the iron produced by this process may be cast and handled by standard iron procedures without subsequent remelting.

PRODUCTION OF NODULAR IRON

U.S. 2,747,990, issued May 29, 1956 to Henton Morrogh and assigned to The British Cast Iron Research Association, describes a process for producing nodular cast iron by the introduction of calcium into the molten metal.

The calcium is preferably added in the form of finely powdered calcium carbide, in order to avoid oxidation. The carbide may be carried in a stream of inert gas, such as nitrogen, under pressure through a tube which extends below the surface of the molten iron. The iron used should be hypereutectic. The amount of calcium added must be sufficient to reduce the sulphur content below 0.02 per cent, and to remove as CaO any oxygen present in the molten iron. The excess above these requirements is all that is available to dissolve in the iron.

After the introduction of the calcium, the molten metal is treated with a graphitising inoculant, such as ferrosilicon. This results in a more uniformly nodular graphite structure, reduces the chill, and improves the mechanical properties.

Another process for producing nodular iron is described by Harry K. Ihrig in U. S. 2,750,284, issued June 12, 1956, and assigned to Allis-Chalmers Manufacturing Co. It consists of bringing together (1) molten iron, (2) sodium chloride and (3) a reducing agent for the sodium chloride, i.e. calcium in the form of the silicide.

METHOD OF PRODUCING TEMPERED OIL WELL CASING

U.S. 2,748,039, issued May 29, 1956 to Orlando P. Adams and William O. C'inedinst, assigned to United States Steel Corp., describes a method of quenching and tempering oil well casing without causing it to become oval in shape or to crack.

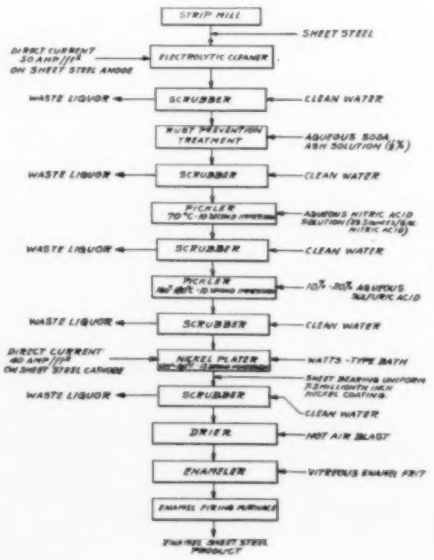
The harmful effects of quenching are avoided by applying the quenching medium as a spray to the exterior only, while preventing the interior from coming in contact with the quenching medium. Further improvement is obtained by reducing the diameter of the casing by 1½ to 2 per cent by compression, while at a tempering temperature of about 700 to 950 F.

PROCESS OF ENAMELING STEEL

U.S. 2,748,066, issued May 29, 1956 to Irving P. Whithouse, Fred E. Kendall, and Paul Golar, and assigned to Republic Steel Corp., describes a process for producing a tenaciously adhering, uniform and continuous finish enamel coating on steel produced by either hot or cold rolling, without first providing a ground coat on the surface.

The principal factors in the invention are the removal of a very thin portion of the strip without pitting the surface, followed by the plating on of nickel of a critical thickness. The process is shown diagrammatically in Figure 4.

Figure 4



BAFFLED TUYERES FOR BLAST FURNACES

U.S. 2,749,112, issued June 5, 1956 to Francis J. Zipper and Henry G. Bolster, provides a method for obtaining uniform discharge of air into a blast furnace from each tuyere. This is accomplished by the insertion of a baffle unit 14 in the conduit between the bustle pipe and the tuyere, as shown in Figure 5 and at B in Figure 6. The back pressure created by the baffling action is sufficient to cause a uniform distribution of air through the tuyeres.

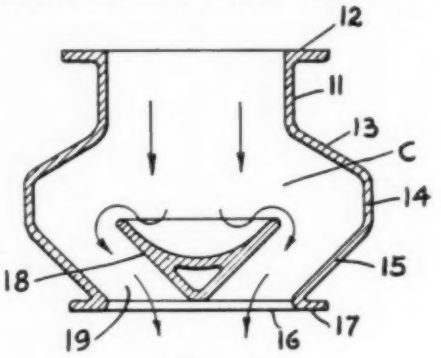


Figure 5

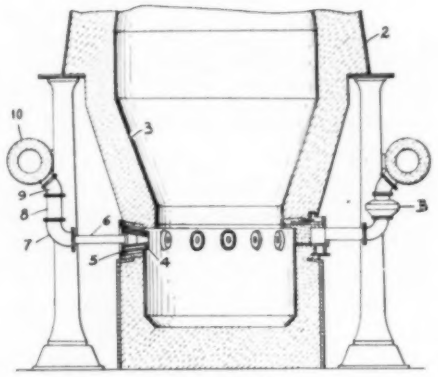
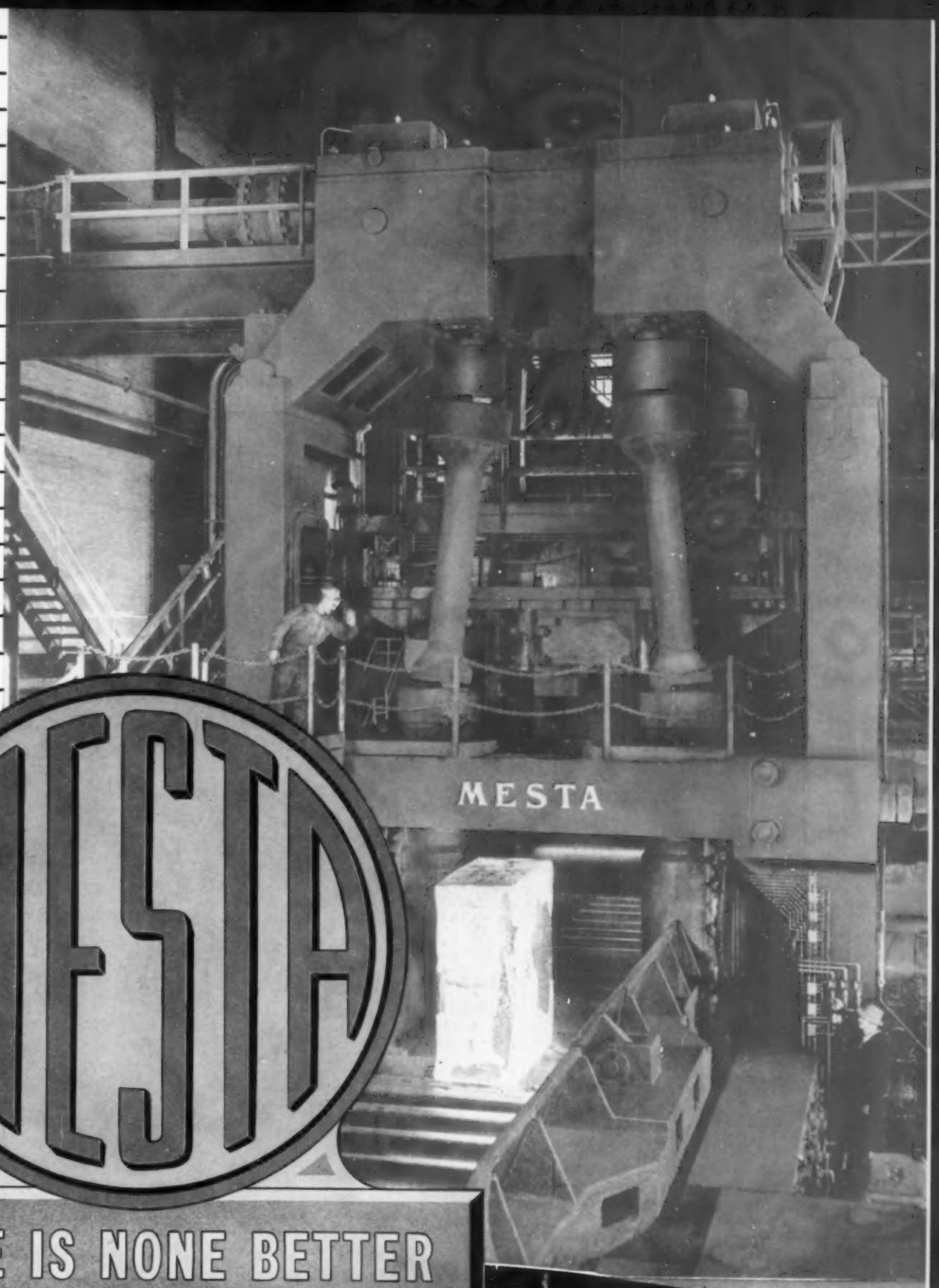


Figure 6

SMELTING APPARATUS

U.S. 2,750,278, issued June 12, 1956 to Anton A. Morvay, Frederick B. Hinrichs, and Cornelius A. Ross, describes a novel type of smelting apparatus, which does not utilize coke as reducing agent or source of heat, which can utilize low grade ores, and which does not require a huge investment.



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DESIGNERS and BUILDERS
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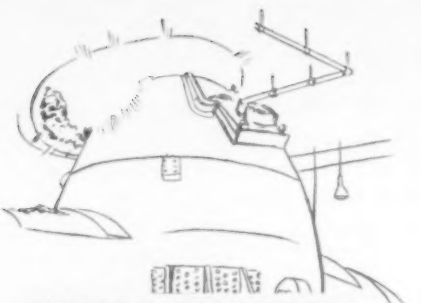
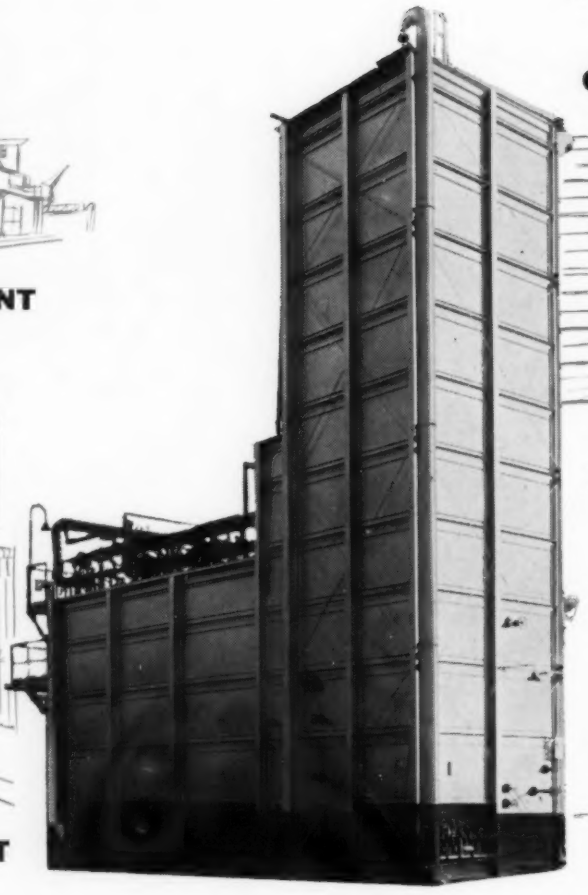
BLAST ENRICHMENT



OXYGEN CONVERTER

SCARFING



FUEL ENRICHMENT

OXYGEN LANCE

ON-LOCATION OXYGEN GENERATORS

are an economic necessity in modern steel-making

Modern steel-making, of course, means "oxygen steel-making". Those steel companies that exploit this new technology to its fullest possibilities are the ones that will pay the biggest dividends.

Fuel enrichment in blast furnace and open hearth, the new oxygen converter, the oxygen lance, scarfing, scrap preparation and—perhaps soon—the desiliconizer, all require oxygen in such huge quantities as to make the use of on-location or "captive" generators an economic necessity. Our experience in providing these units for Weirton, Granite City, Jones and Laughlin and other prominent steel companies proves this point.

Air Products will install, on a lease basis without capital investment by you, if desired, an oxygen and/or nitrogen generating station to meet your particular requirements. We design and manufacture:

Large capacity tonnage generators for unlimited quantities of oxygen and nitrogen regardless of size, purity or cycle and "Packaged" High-Purity Generators, producing high-purity oxygen and nitrogen separately or simultaneously.

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AP

As shown in Figure 7, the shaft 5 is filled with iron oxide ore and limestone, and this mixture flows by gravity through a restricted throat 8 onto a hearth 16. Burners 17 are supplied with air and pulverized coal, giving a high temperature flame and a combustion gas rich in CO. The flames are directed against the side of the column of solid charge materials, reducing the iron, slagging the gangue, and melting the slag and

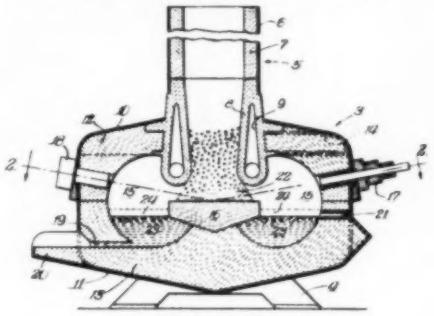


Figure 7

metallic iron. All these reactions take place within the furnace 3 itself and not within the stack 5, as the combustion gases cannot penetrate the column of charge materials. The particle size of the charge materials is about ⅜ in.

Molten iron 23 and slag 24 are tapped from the furnace, as shown. A pressure of about 1 to 5 psi is maintained in the furnace by means of blast gates 18.

RAPID DESULPHURIZATION OF STEEL

U.S. 2,750,280, issued June 12, 1956 to Rene Perrin and Jean Lamberton, assigned to Societe d'Electro-Chimie D'Electro-Metallurgie et des Acieries Electriques D' Ugine, describes a process for rapidly desulphurizing steel.

According to the patent, a desulphurizing slag has been developed which can be premelted, solidified and pulverized, or sintered and pulverized, and used in the form of solid particles by adding it to the steel while it is being poured into a ladle. This obviates the need of providing a slag melting furnace in the steelmaking shop. The slag consists of about 80 per cent fluorspar and 20 per cent lime.

CONTINUOUS HORIZONTAL HOT MOLTEN METAL CASTING APPARATUS

U.S. 2,751,647, issued June 26, 1956 to Benjamin Brownstein, describes a process for continuous casting molten metal in horizontal open top molds, without agitation or turbulence and with no overflow. In addition, the molds are readily stripped from the cast article without lifting, jarring, or similarly disturbing it.

Molten metal is flowed in a direction parallel to the floor of the mold. The source of the flow is continuously moved relative to the mold, at such a rate that the volume of the mold thus traversed is equal to the volume of molten metal received. Thus, the air in the mold is evenly replaced with the cast molten metal.

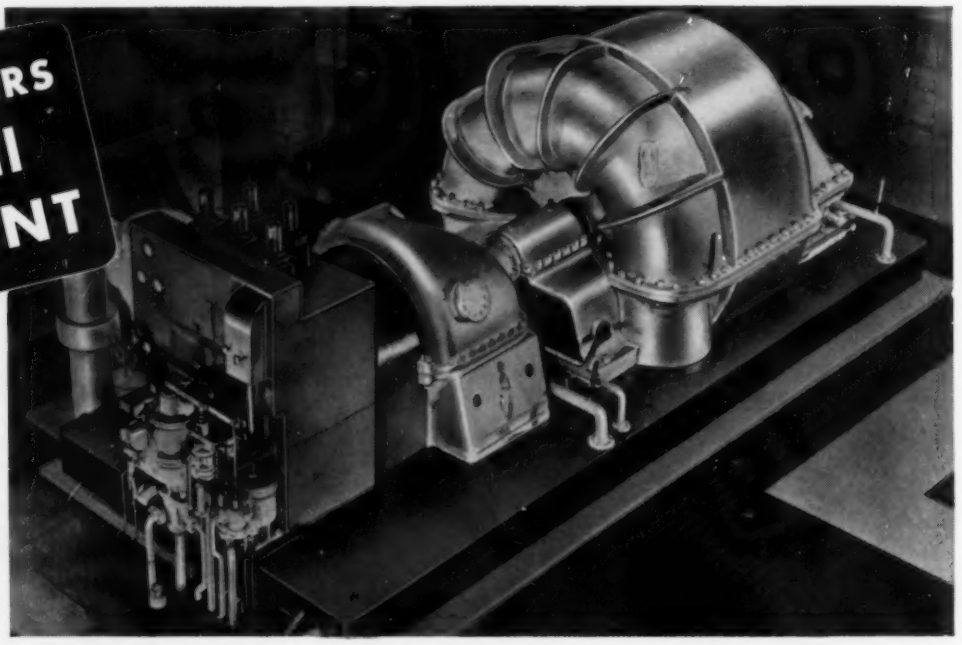
The apparatus used to accomplish this uniform, nonturbulent deposition of molten metal includes a funnel-shaped member having a curved spout to provide a horizontal exit. This member is lowered into the mold and moved relative to it.

OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

Patent No.	Date	Subject	Inventor or Assignee
2,747,270	5/29/56	Forging process	J. I. Case Co.
2,747,965	5/29/56	Recovery of manganese from ores	Republic Steel Corp.
2,747,987	5/29/56	Separating iron values from titaniferous iron material	National Lead Co.
2,747,989	5/29/56	Forgable high strength ferritic alloy	Firth-Vickers Stainless Steels Ltd.
2,748,038	5/29/56	Roll quenching and straightening cylindrical elongated workpieces	The Gleason Works
2,749,106	6/ 5/56	Protection of hot metallic bodies against oxidation	Metallurgical Processes Co.
2,749,107	6/ 5/56	Insulated water-cooled furnace members	John W. Corriston
2,749,108	6/ 5/56	Billet heating furnace	Selas Corp. of America
2,749,110	6/ 5/56	Recuperator	Walter Hartwig
2,749,111	6/ 5/56	Vacuum seal for fan shaft of heat-treating furnace	Surface Combustion Corp.
2,749,173	6/ 5/56	Gripping apparatus for handling bessemer tuyeres	United States Steel Corp.
2,749,234	6/ 5/56	Production of iron powders	Morris Eisenberg
2,749,624	6/12/56	Apparatus for determining the profile of threads	United States Steel Corp.
2,750,187	6/12/56	Apparatus for maintaining a loop of continuous strip at entry end of a processing line	United States Steel Corp.
2,750,272-4	6/12/56	Production of hard burned agglomerates of fine magnetite ore	Allis-Chalmers Mfg. Co.
2,750,275	6/12/56	Method of treating materials containing sulphides	Orville J. Parker
2,750,276-7	6/12/56	Apparatus for smelting fine iron ore	Armco Steel Corp.
2,750,279	6/12/56	Treating cast iron with iron-fluorine compounds	The Pennsylvania Salt Mfg. Co.
2,750,282	6/12/56	Stainless steel of the "20" type	Cooper Alloy Corp.
2,750,286	6/12/56	Production of iron-nickel alloys from low grade ores	Societe d'Electro-Chimie d'Electro-Metallurgie et des Acieries Electriques d'Ugine
2,750,853	6/19/56	Wire finishing apparatus	Armco Steel Corp.
2,750,923	6/19/56	Hot dip galvanizing apparatus	General Electric Co.
2,751,291	6/19/56	Alloy steel	The Eimco Corp.
2,751,649	6/26/56	Holder for hot-top supporting blocks	United States Steel Corp.
2,751,916	6/26/56	Apparatus for use in pickling bars and tubes	Patents and Investments Ltd.
2,752,147	6/26/56	Heat-treating furnace	Leeds & Northrup Co.
2,752,148	6/26/56	Electronic heat treating device	Westinghouse Electric Corp. et al
2,752,183	6/26/56	Apparatus for unfastening coke oven doors	Koppers Co., Inc.
2,752,223	6/26/56	Production of ferric chloride	The United Steel Companies Ltd.
2,752,234	6/26/56	Continuous gaseous reduction of iron ore in a fluidized bed system	United States Steel Corp.
2,752,235	6/26/56	Method and apparatus for making steel	Ethel M. Burke
2,752,238	6/26/56	Straight chrome stainless steel pressure vessel	United States Steel Corp.
2,752,268	6/26/56	Bonding a coating of aluminum to a plain carbon steel base	Whitfield & Sheshunoff
2,752,274	6/26/56	Method of bright heat-treating metals	Westinghouse Electric Corp.
2,752,299	6/26/56	Electrolytic production of manganese and ferromanganese	Walter M. Weil
2,752,301	6/26/56	Recovery of chromium and iron values from chromium-iron ores	Walter M. Weil
2,752,410	6/26/56	Electrical reduction furnace	Sunrod Mfg. Corp.

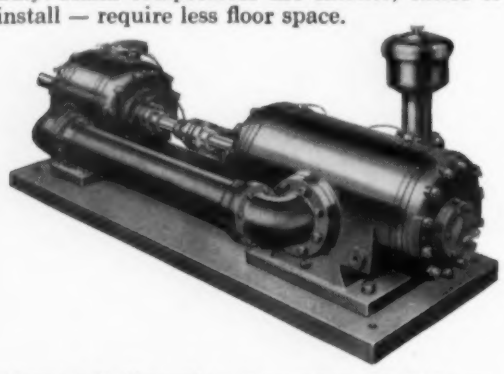
Top Efficiency Compressors For *ANY* Steel Mill Duty

ALLIS-CHALMERS Steel Mill EQUIPMENT



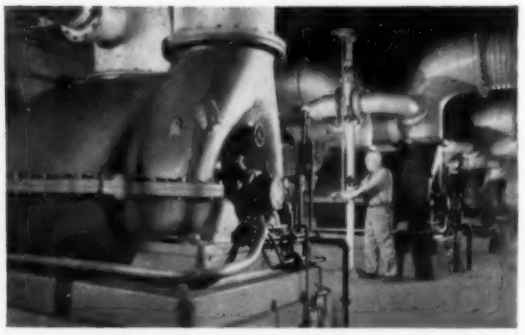
Blast Furnace Blowers — Allis-Chalmers manufactures a complete line of centrifugal units for blast furnaces. The 75,000-cfm, 30-psig blower shown at right, placed in operation in 1942, is driven by an Allis-Chalmers 8500-hp steam turbine.

Allis-Chalmers also builds a wide range of axial compressors for high efficiency blast furnace duty. Axial compressors are smaller, easier to install — require less floor space.



Plant Air Supply — Two-stage *Ro-Flo* compressor delivers plant air supply with constant efficiency; cuts maintenance requirements. If wear occurs, it automatically compensates for itself so that air supply is unaffected.

From Blast Furnace to Plant Air, Allis-Chalmers Compressors Give High Efficiency at Lowest Installation and Operating Costs



Coke Oven Blowers — Allis-Chalmers centrifugal types are recommended for booster, exhauster, or combination booster-exhauster service. Photograph shows four 23,000-cfm, 5100-rpm, 3.5-psig exhausting blowers in a western steel mill.

Allis-Chalmers has had wide experience building and applying compressors of all sizes and types. For help with your air and gas handling problems, call the A-C office in your district, or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin.

A-4865

Ro-Flo is an Allis-Chalmers trademark.

ALLIS-CHALMERS

Lapointe Machine Tool Company, Hudson, Massachusetts

FIRST OF ITS KIND IN THE WORLD!

...And It's Lubricated by Cities Service Pacemaker 400 T Oil!

LAPOINTE MACHINE TOOL COMPANY, originator of the broaching method of cutting metal over 50 years ago, has now originated the first vertical broaching machine with variable speed electro-mechanical drive.

Purpose of the huge, gear-driven machine is to increase tool life up to 500% through smoother operation, thus saving down time and producing more accurate work.

Selection of a lubricant for the new machine was of special importance because of the tremendous pressures it develops: normally 30,000 pounds, sometimes up to 60,000 pounds. Of the many brands of lubricants Lapointe tested, Cities Service Pacemaker 400 T had the necessary requirements for the job . . . so naturally, this superior lubricant got the job.

"We test the machines with Pacemaker 400 T at the factory and then put it in again when the broaches are assembled at the buyer's plant," says Lapointe. "It offers all the characteristics we need: Good film strength, high viscosity index, and exceptional anti-foam and anti-oxidant qualities. Needless to say, we're pleased and impressed with this Cities Service lubricant."

Like scores of others, Lapointe has discovered the search for a proper lubricant ends at the Cities Service label. Altogether, there are hundreds of Cities Service products for the exacting needs of industry. For more information, talk with your nearby Cities Service Lubrication Engineer. Or write: Cities Service Oil Company, Sixty Wall Tower, New York 5, N. Y.

Quick Facts About New Broaching Machine

USES: Now used for broaching aircraft engine turbine buckets, but can be adapted to general broaching.

ADVANTAGES: Increases tool life 400-500% through smoother operation, less down time. Produces more accurate work. Variable cutting speed: 12 to 75 FPM. Available in single or double ram models with 72" to 100" stroke.

Quick Facts About Pacemaker 400 T Oil

USES: Propulsion turbine units where oil is circulated under heavy pressure. Widely used in naval and commercial vessels, high speed industrial machinery.

ADVANTAGES: High viscosity index, excellent heat resistance and film strength. Chemically fortified against oxidation, rust, and foaming.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS

VICTOR R. BROWNING

Mill Type Cranes

TO SPECIFICATION...

Basically designed as required by A.I.S.E. specifications, mill type cranes built by Victor R. Browning & Co., Inc. also offer the opportunity of specifying preferences and standards prevailing in the purchaser's plant. May we have your next inquiry?

VICTOR R. BROWNING & COMPANY, Inc.

WILLOUGHBY (CLEVELAND), OHIO

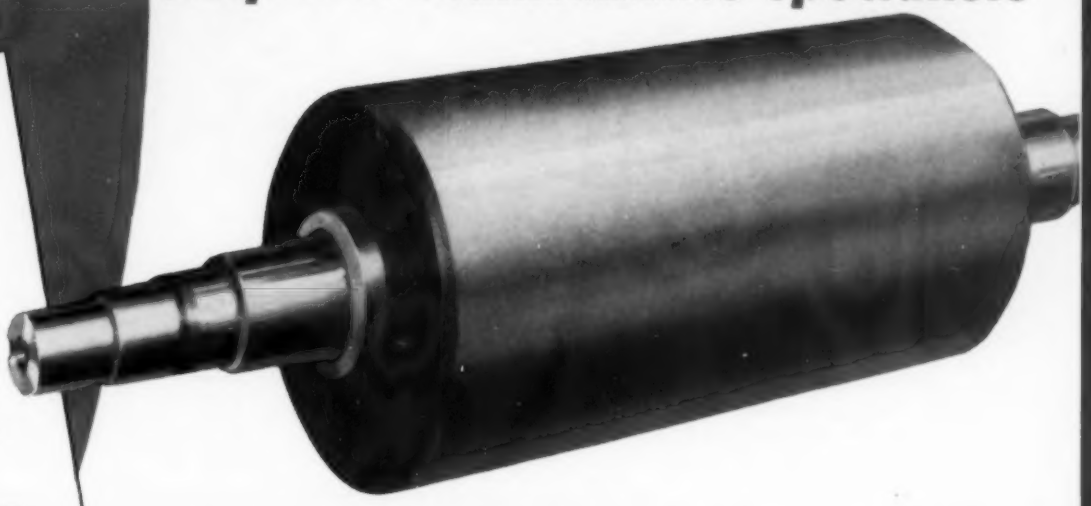
DESIGNERS AND BUILDERS OF ELECTRIC OVERHEAD TRAVELING CRANES AND HOISTS AND ELECTRIC REVOLVING CRANES

Get the right answers to your Roll problems from "YOUNGSTOWN"

hot and cold strip mill maintenance specialists

Q. How can scratching, galling, pickup, and excess wear be eliminated?

A. Use PARALLOY... the Rolls of uniform hardness all through. Roll more tonnage from new to scrap diameter.



PARALLOY

HOT STRIP COILER ROLLS • COILER PINCH ROLLS
PICKLING LINE PINCH ROLLS • UPCOILER ROLLS
CLEANING LINE PINCH ROLLS • SINKER ROLLS
CARRIER ROLLS • TEMPER MILL TENSION ROLLS

Q. How can heat check, warpage and cracking be overcome?

A. Let Youngstown's proven experience with Ductile Cast Iron help you in the applications at right.

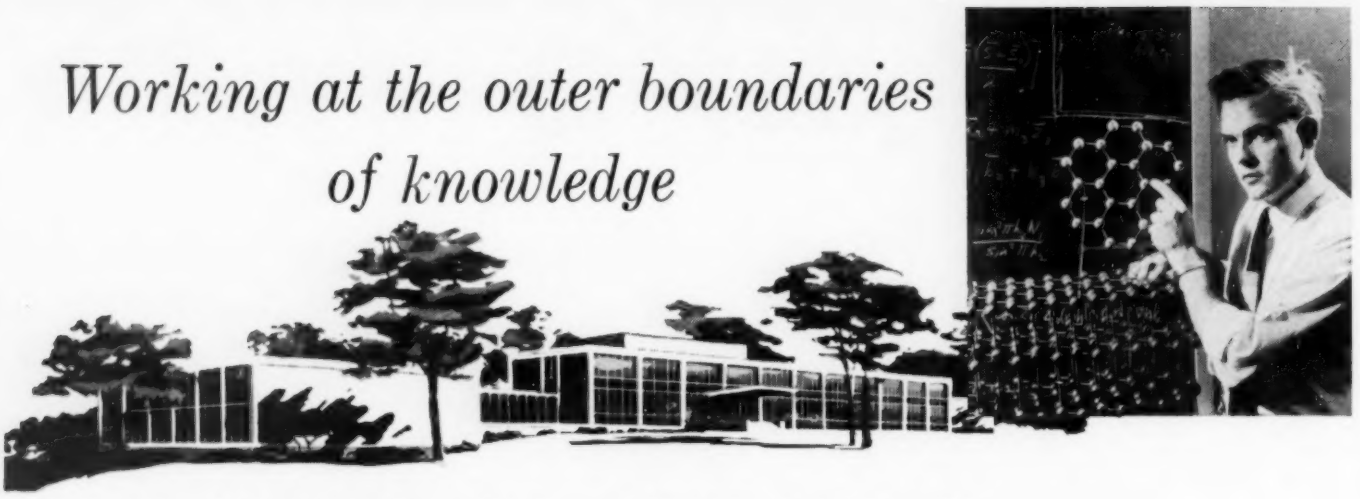
DUCTILE IRON

RUNOUT TABLE ROLLS • HOLDING TABLE ROLLS
LOOPER TABLE ROLLS
LOOPER TABLES • APRON PLATES

Ductile Cast Iron Rolls are reducing maintenance in hot strip mills . . . especially good under the sprays. We invite your inquiries on rolls or any other ductile iron castings up to 50,000 pounds.

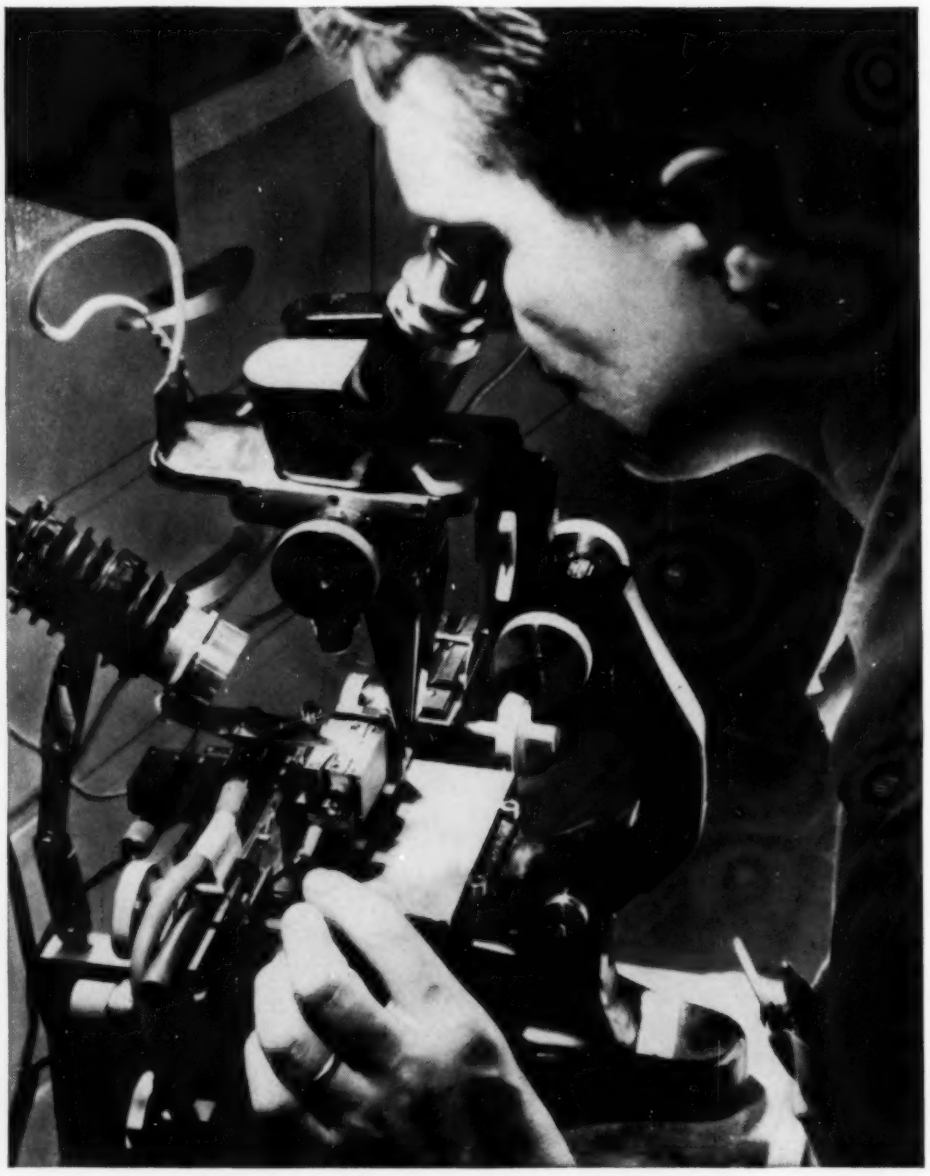
The Youngstown Foundry & Machine Co.
SERVING INDUSTRY SINCE 1883
Youngstown, Ohio

Working at the outer boundaries of knowledge

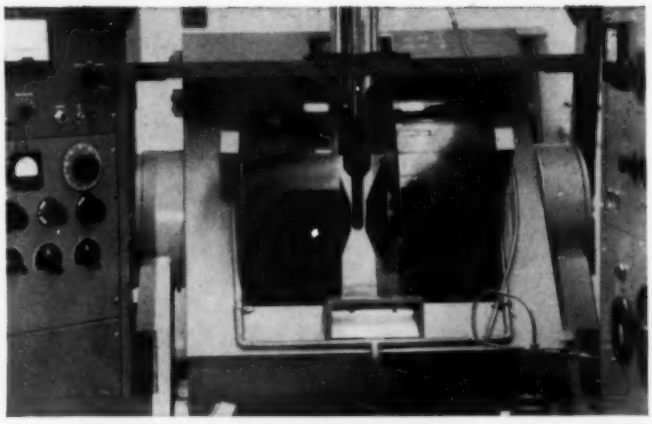


New Research Laboratories in Parma, Ohio. To expand its pioneering work in solid state and chemical physics, National Carbon Company has enlarged its staff of scientists and provided them with an ideal laboratory setup for creative work. Typical of their modern experimental equipment is an *arc radiation furnace* used for work on high-temperature refractories. It can bring light from a carbon arc into focus on a tiny pin-point area, *achieving an intensity* of several hundred million foot-candles — *approaching the intensity of light near the surface of the sun.*

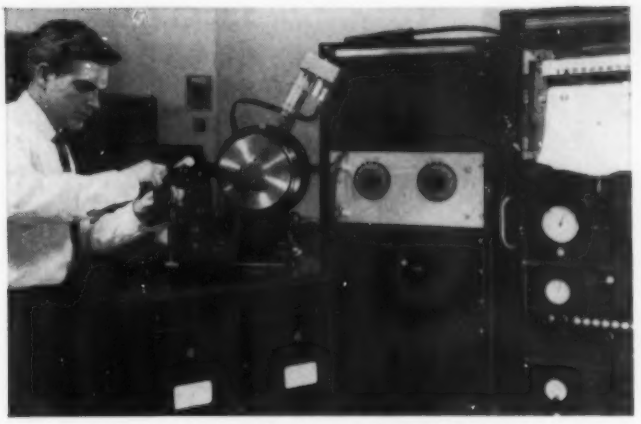
New



Mechanized tweezers handle graphite crystal. To make it into a proper experimental guinea pig, the fragile crystal must be painstakingly cut and mounted so that electrical flow can be measured along the unique crystalline directions in graphite. Experiments with pure crystals are important because all materials which we know as carbon and graphite are basically composed of the same graphite crystals being prepared here. Tremendous differences in electrical behavior and other vital properties can be traced to variations in size and arrangement of the graphite crystals in carbon products.



Graphite must pass good-conduct test. A tiny graphite crystal is chilled to within one degree of absolute zero, then held between poles of a powerful electromagnet, while electrical conductivity is measured in each crystalline direction — one of many ways to learn more about carbon.



X-ray "scatter" test reveals secrets of graphite. Testing the x-ray diffraction of carbon and graphite samples gives researchers a picture of relationships between crystals in carbon and graphite materials. This is another experimental method for probing the mysteries of carbon.

break-through in carbon physics research

promises future advances in furnace electrodes, linings, carbon brushes and other needs of the metal industries

One more barrier is down. And science strides forward in the age-old quest for deeper knowledge of carbon, one of nature's more complex puzzles.

This barrier—the inability to get large graphite crystals pure enough for experimental needs — has now been overcome by researchers of National Carbon Company. Their new annealing techniques, which remove impurities from large graphite crystals, also eliminate imperfections and weaknesses in the crystalline structure.

Several research teams at the new Parma laboratories are exploiting this break-through of science. The purified crystals are being subjected to a variety of experimental tortures—electrical, magnetic and thermal. Fundamental facts about the behavior of the single graphite crystal are being gathered and pieced together like jigsaw cutouts—building up a more complete and systematic picture. In this way, our scientists will be better able to *predict* the properties of new carbon and graphite materials.

The work on single graphite crystals is only one phase of a broad research program in carbon physics. The metals industries, as large users of carbon and graphite products, will share in the gains from this work of science at the outer boundaries of knowledge. Write for new booklet titled "Research," telling more about the work at the new Parma laboratories.

Look to **NATIONAL CARBON**

for leadership in carbon and graphite products

NATIONAL CARBON COMPANY • **A Division of Union Carbide and Carbon Corporation** UCC **30 East 42nd Street, New York 17, N. Y.**

Sales Offices: Atlanta, Chicago, Dallas, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco. *In Canada:* Union Carbide Canada Limited, Toronto

IN A FEW HOURS ALL* OTHER ROTARY STRAIGHTENERS WILL BE OLD-FASHIONED !

(*Excepting, of course, the 52 units of this type now in service.)

MANNESMANN-MEER Engineering and Construction Company, Inc., 900 Line Street, Easton, Pennsylvania

a few of the many types of
SPRAYING SYSTEMS CO.

spray nozzles

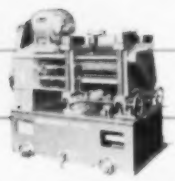
installed at the
Fairless Works

. . . for such operations as roll cooling on hot and cold mills • descaling • runout table cooling • pickling line • cooling slabs on transfer table • cooling ingot molds • cooling open hearth tunnels or checkers • cooling pigs • coke chemical processing • spraying lubricants • and air and gas washing

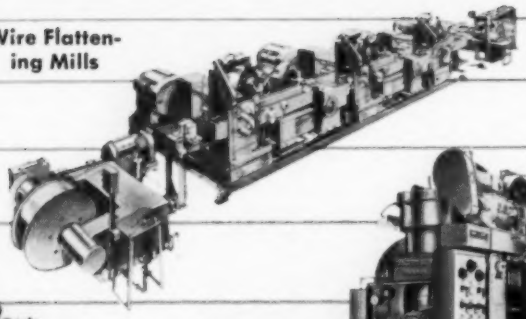
For every spraying operation, you will find Spraying Systems spray nozzles offer impressive, measurable advantages. That is why they have been so widely selected for application in the Fairless Works. Spraying Systems spray nozzles are made in a very wide range of types and sizes for exact performance to meet your specifications . . . products of America's leading designer and manufacturer of spray nozzles for industry. Your inquiry is cordially invited.

SPRAYING SYSTEMS CO.
3262 RANDOLPH STREET • BELLWOOD, ILLINOIS

Write for your FREE copy of new Catalog No. 24 . . . the most comprehensive spray nozzle catalog ever produced.

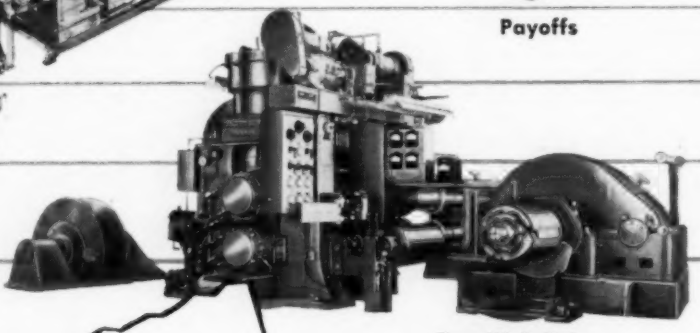


Coilers

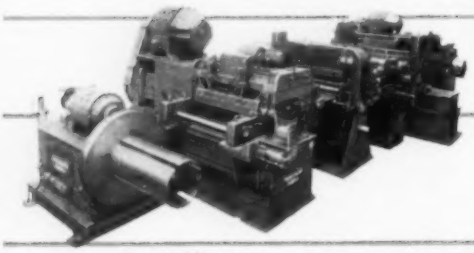


Wire Flattening Mills

Payoffs



Two High Strip Rolling Mills

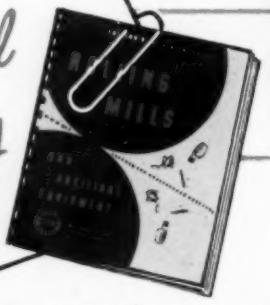


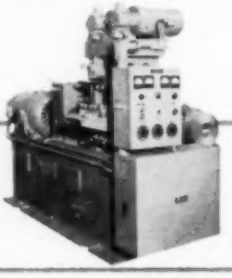
Gang Slitters

MEMO

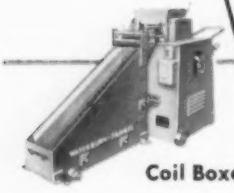
Re Rolling Mill Modernization

Look Into Latest Waterbury Farrel Mill Machinery



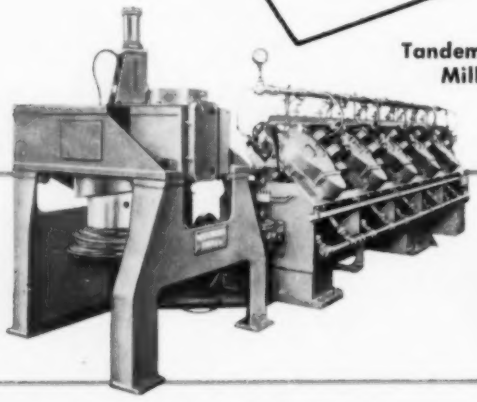


Four High Strip Rolling Mills

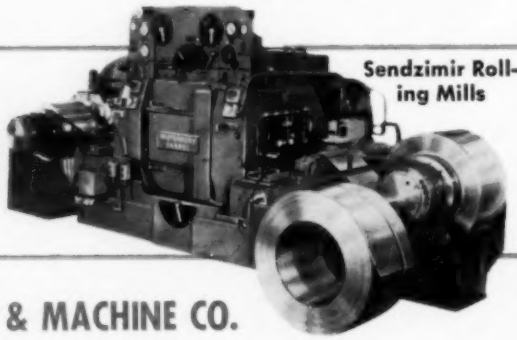


Coil Boxes

NEW, 48 PAGE MILL MACHINERY CATALOG. Gives a complete picture of the various types of mills and auxiliary equipment built by Waterbury Farrel. Send for your copy, today.



Tandem Rod Mills



Sendzimir Rolling Mills

ROLLING MILL EQUIPMENT

- Four-High Rolling Mills
- Gang Slitters
- Grading Mills
- Mint Mills
- Sendzimir Rolling Mills
- Special Rolling Mills
- Two-High Rolling Mills

AUXILIARY EQUIPMENT

- Coil Boxes
- Coilers
- Coil Lifts and Transfers
- Belt Wrappers
- Edgers
- Handling Equipment
- Payoffs
- Straighteners
- Winders

ROD AND TUBE MILL EQUIPMENT

- Draw Benches
- Tandem Rod Mills
- Three-High Rod Mills
- Two-High Rod Mills

THE WATERBURY FARREL FOUNDRY & MACHINE CO.

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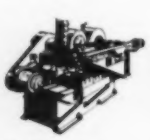
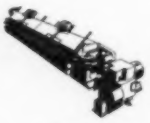


Bolt, Nut & Screw Machinery

Power Presses

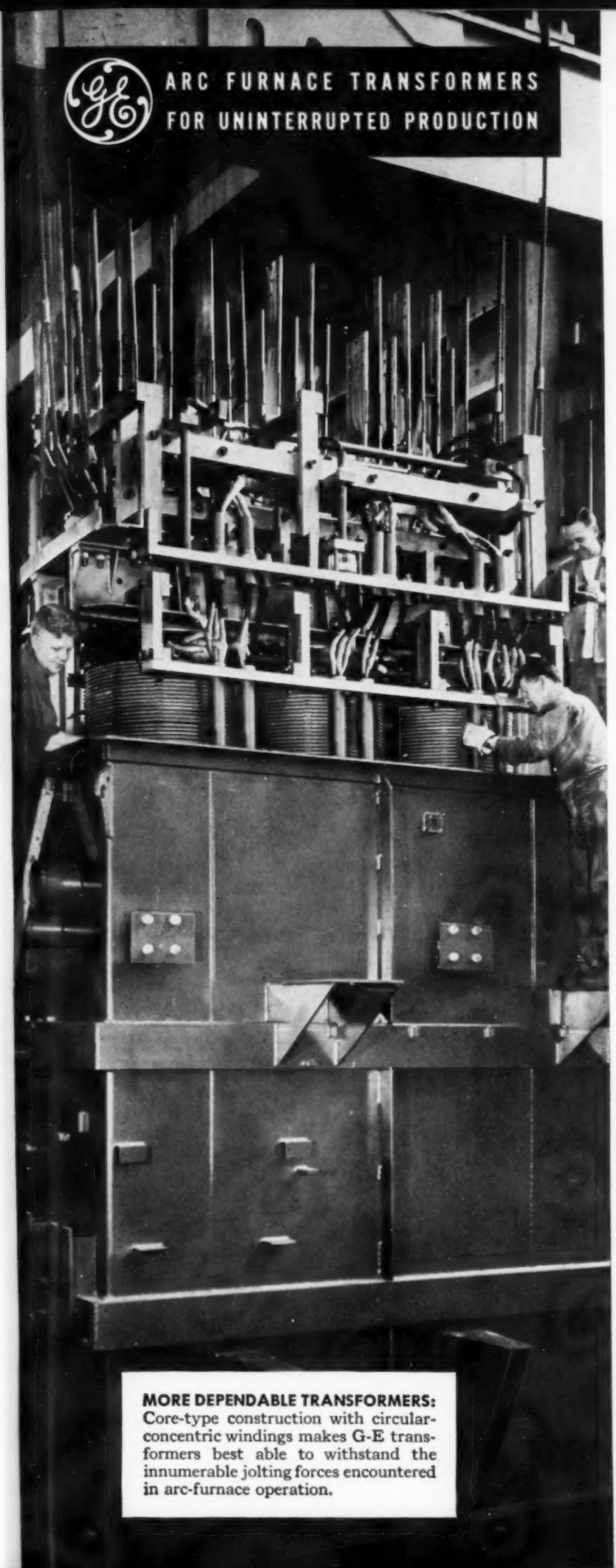
Rolling Mill Machinery



Wire Mill Equipment

Sendzimir Mills & Other Special Machinery

WF-31



MORE DEPENDABLE TRANSFORMERS: Core-type construction with circular-concentric windings makes G-E transformers best able to withstand the innumerable jolting forces encountered in arc-furnace operation.

G-E transformers keep your furnaces on the job

HERE'S WHY:

TREMENDOUS AND FREQUENT current surges during the meltdown period subject the windings and core clamps of furnace transformers to severe pounding stresses found in no other transformer application. The low-voltage bar-lead structure may also be subjected to forces more than 1000 times those encountered in normal power-transformer operation. General Electric Arc-Furnace Transformers are designed and built especially for this rugged service.

INHERENTLY STRONGER. Circular-concentric windings, used in all G-E transformers, are inherently stronger than other designs. A circular coil is far better able to withstand radial stress (the kind imposed by current surges), than a coil of any other shape. These coils are kept in place by a sturdy clamping structure, to prevent any shifting or deformation which could lead to failure.

GREATER STRENGTH is only one of many reasons why you should specify G-E transformers for your next arc-furnace installation. Others include: better cooling for more accurate control of hotspots, and a superior tap changer which has proved itself by a record of no contact-tip failures in over eighteen years.

For the full story, contact your nearest G-E Apparatus Sales Office or write to General Electric Company, Section 422-28, Schenectady 5, N. Y.

Progress Is Our Most Important Product

GENERAL ELECTRIC

GENERAL ELECTRIC ANNOUNCES

static switching systems

General Electric's new static switching systems have been designed to increase significantly the dependability and life of control equipment where frequent operations, complex systems, and continuous processes are required or atmospheric problems exist.

These new G-E systems utilize static-magnetic and solid-state devices to perform a variety of control functions normally accomplished by contact-making devices. Static switching systems consist of varied combinations of seven basic units: an isolation switch unit, two multi-purpose units, a long time-delay unit, a short time-delay unit, an "AND" unit, and an "OR" unit. These units can also be combined with static power supplies, static amplifiers, and static regulators to provide completely static control systems.

Where frequent operations are involved, static switching systems are ideal, as they have no moving parts to wear.

Where complex control functions are required, the simplified circuitry of the static switching systems makes them particularly applicable.

For continuous processes, these systems assure dependability through the use of pre-tested, industry-proved static components.

Unaffected by most atmospheric conditions, the static units are encapsulated in an inert, lightweight compound.

General Electric control engineers are ready now to help you apply the benefits of static switching systems to your machines or processes. For additional information, contact your nearest General Electric Apparatus Sales Office, or write for Bulletin GEA-6364 to Sect. 785-2, General Electric Co., Schenectady 5, New York. *Industry Control Dept., Roanoke, Virginia.*

Progress Is Our Most Important Product

GENERAL ELECTRIC

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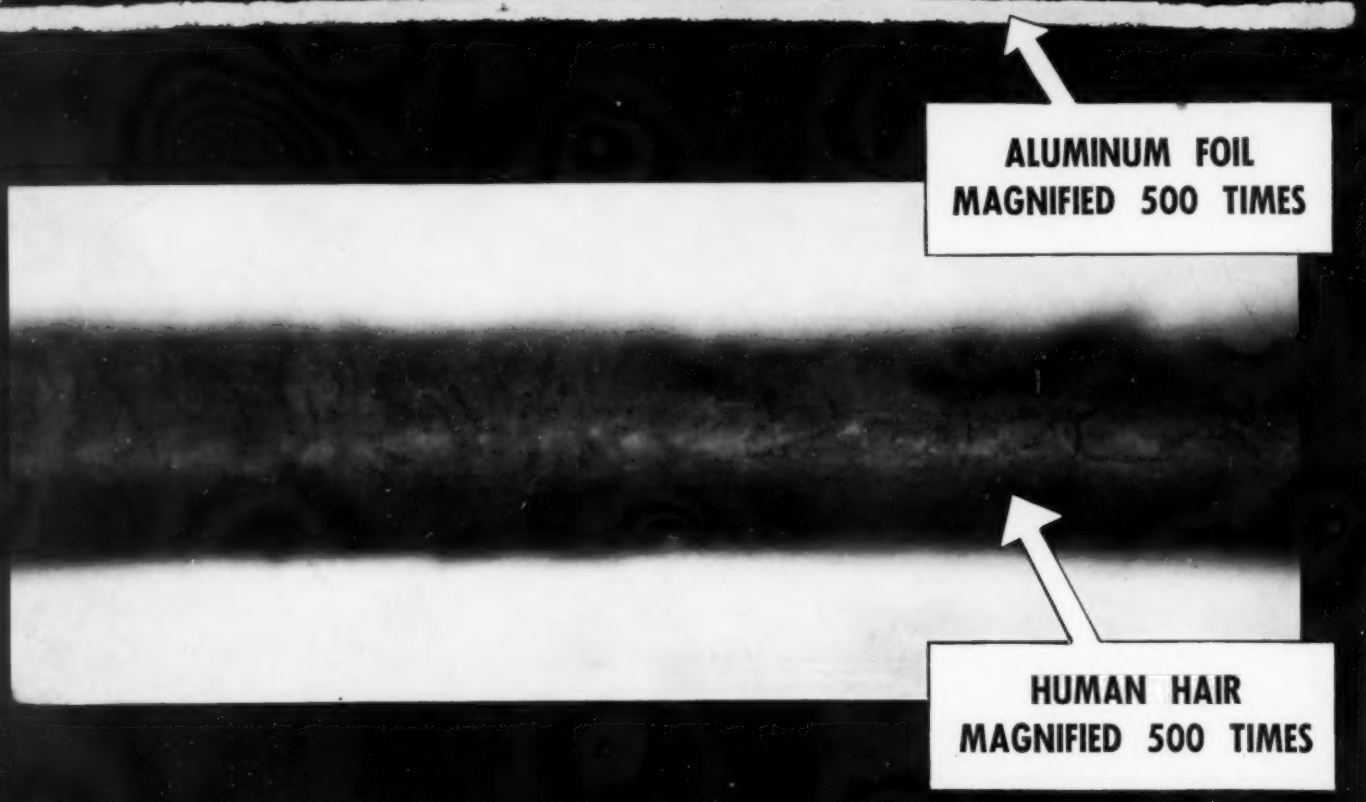


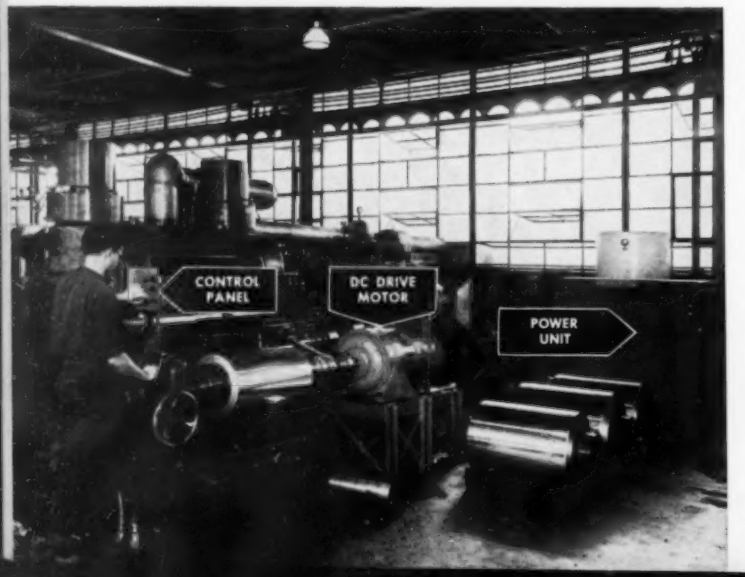
General Electric d-c drives help

Roll aluminum 1/10 the thickness of human hair

A GENTLE TOUCH—Rolling high-quality aluminum to 1/10 the thickness of a human hair takes a gentle touch. Doing it 24 hours a day, six days a week demands sturdy, reliable equipment. To obtain this combination of sensitivity and dependability Republic Foil and Metal Mills, Danbury, Conn., has installed five General Electric Speed Variators on their pay-off drives.

REDUCED DOWN-TIME—Mr. James D. Post, Vice President in Charge of Operations, reports, "The General Electric Speed Variators provide more constant tension and steady acceleration. As a result, down-time and maintenance have been reduced on this delicate work. We also like the way they stand-up under continuous operation. Our satisfaction is manifest in a duplicate order for our No. 5 mill."

THREE COMPONENTS of G.E.'s Speed Variator are shown installed on the pay-off drive at Republic Foil and Metal Mills.

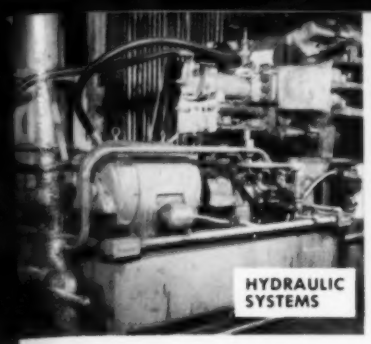


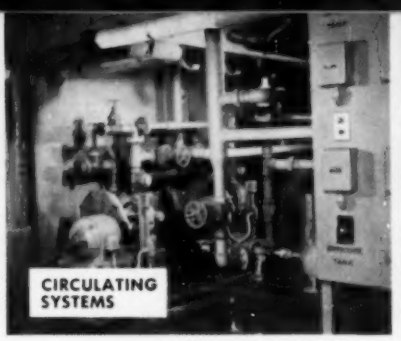
SPLIT-SECOND RESPONSE—General Electric Speed Variators are proving the answer to a variety of difficult metal rolling and slitting applications in brass, aluminum, and steel. Providing smooth, steady acceleration and split-second response to control signals, they can meet the most exacting drive requirements.

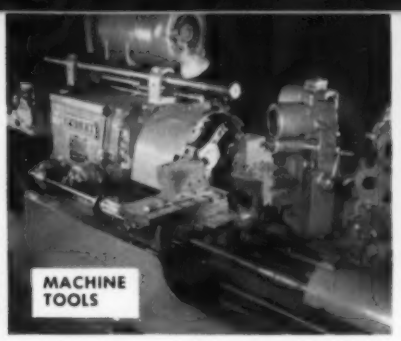
ENGINEERED TO YOUR SPECIAL NEEDS—The Speed Variator conversion unit comes assembled, wired and tested... ready to be installed on your a-c system. General Electric engineers will be glad to help you in making the most effective use of these drives. Please call your G-E Apparatus Sales Office or write for bulletin GEA-6127. *Direct Current Motor and Generator Department, General Electric Company, Erie, Pennsylvania.* 820-2

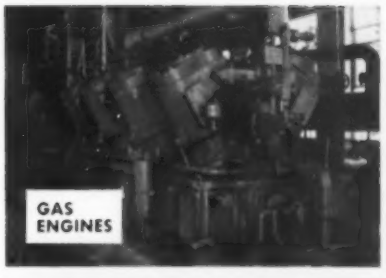
Progress Is Our Most Important Product

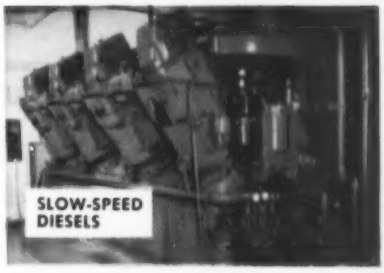
GENERAL ELECTRIC











SUN SOLNUS OILS IDEAL LUBRICANTS FOR 80% OF ALL APPLICATIONS

Moderately priced...low in carbon-forming tendencies, Sun Solnus® oils simplify your storage problems by doing with *one oil* many jobs that would otherwise require *several.* Their ability to protect metal parts against corrosion, their resistance to oxidation, and their moderate price all add up to "more lubrication per dollar."

For technical information, see your Sun representative, or write to SUN OIL COMPANY, Philadelphia 3, Pa., Dept. I-51.

SUNOCO

INDUSTRIAL PRODUCTS DEPARTMENT

SUN OIL COMPANY

PHILADELPHIA 3, PA.

© SUN OIL CO.

In Canada: SUN OIL COMPANY LIMITED, Toronto and Montreal

Valve on left is from compressor run for 3,000 hours with well-known, high-grade oil. At right is same valve after a 3,000-hour run with Sun Solnus oil. Note difference in carbon deposits.

3000-HOUR TEST PROVES SUN SOLNUS OILS REDUCE CARBON BUILD-UP IN COMPRESSORS

Equipment: A three-stage Norwalk horizontal-type compressor. Operating pressure: from 1,000 to 1,500 psi.

Test: The compressor was cleaned thoroughly and filled with a well-known, high-grade oil. The equipment was run for 3,000 hours, then torn down for inspection and cleaning. Then Solnus® 300 was tested in the same way.

Results: Look at the two pictures. You can see for yourself how Solnus oil reduced dangerous carbon build-up.

All types of reciprocating air compressors that have been changed over to a Sun Solnus oil show similar results. A test in your compressor will show the same remarkable reduction of carbon deposits.

You can get a technical bulletin about Sun Solnus oils by asking your Sun representative, or write to SUN OIL COMPANY, Philadelphia 3, Pa., Dept. I-52.

SUNOCO®

INDUSTRIAL PRODUCTS DEPARTMENT

SUN OIL COMPANY PHILADELPHIA 3, PA.

© SUN OIL CO.

IN CANADA: SUN OIL COMPANY LIMITED, TORONTO AND MONTREAL

Poundage and Tonnage in Forged-Steel Rolls

When considering steel rolls, mill men sometimes think of us in terms of tonnage only. But, as this photograph attests, not all of the rolls we produce are of awesome dimensions. Some, in fact, are so small that their weight is less than a hundred pounds.

That little one across the shopman's knee is a case in point. It wouldn't weigh a hundred pounds wringing wet. But it's proof of the old saying that good things come in small packages. Note the beautiful workmanship from end to end.

At Bethlehem, however, quality also comes in big packages. One example would be that second roll in the photograph. It is a giant that took many weeks to create. At every step along the route, it was given the most exhaustive inspections and tests. Finish-machined it weighs upwards of 22 tons, and its quality matches its size.

You'll find Bethlehem forged rolls dependable, no matter what the size or type. They are recommended for cold-rolling ferrous sheets and strip . . . running-down and finishing operations on copper and brass sheets. . . hot- and cold-rolling aluminum sheets . . . cold-rolling aluminum foil.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

By building this blast furnace off-site...

GRANITE CITY STEEL COMPANY'S new blast furnace. It has a hearth diameter of 25 feet (expandable to 26 feet, 6 inches) and a capacity of approximately 1,200 net tons of iron a day, twice that of the furnace it replaces.

Koppers cuts downtime for Granite City Steel

When Granite City Steel Company, Granite City, Illinois, decided to replace Blast Furnace "A" with a much larger furnace, there was *more than the usual concern* over downtime. Only the adjacent furnace was available to supply hot metal for the company's seven open hearths during this period of shutdown.

PHOTO SHOWS FURNACE BEING MOVED. Shell and superstructure of new blast furnace weigh 635 tons – are as high as a 15-story office building. Furnace was built off-site, then moved 84 feet. It was lowered into final position by eighteen 100-ton jacks.

To keep loss of pig-iron production to a minimum, the Freyn Department of Koppers Engineering and Construction Division used the off-site method of construction—a method rarely used in the history of American steelmaking.

While old furnace "A" was still producing iron, the shell of the new furnace was built some distance away. The old furnace was then blown out and dismantled; the foundation was rebuilt and the hearth and columns for the new furnace were constructed in place. Then, the new shell and superstructure, weighing 635 tons, were moved 84 feet and lowered onto the columns.

According to officials of Granite City Steel, this off-site method of construction saved between 30 and 40 days' downtime. The new Koppers furnace is now in operation, and already operating at about 90 per cent of rating.

During the brief shutdown period while work on the stack was in progress, an additional 1,650 tons of steel were erected in the form of three stoves, a dustcatcher, gas washer, precipitator, and interconnecting mains. The skip pit was extensively revised to accommodate larger skip tubs. A new hoist house and complete charging facilities were also part of this well-timed job.

The new Koppers furnace is an important step in reaching Granite City's goal of over 30 per cent increase in annual ingot capacity.

Designing and constructing blast furnaces is just one way in which Koppers serves the steel industry. For any kind of metallurgical construction, you can count on Koppers. You are invited to consult with our Engineers and Management.

FREYN DEPT., KOPPERS COMPANY, INC.
PITTSBURGH 19, PENNSYLVANIA

KOPPERS

KOPPERS

ENGINEERING AND CONSTRUCTION

These slabs are still smoking. Yet, they're on their way to conditioning via Clark-Ross Carrier. There's no faster way to move material between mills.

Allegheny Ludlum "heat treats" their Clark-Ross* Carriers...moves loads while they're hot!

Here's a natural for the steel industry—the self-loading Clark-Ross Carrier. No tracks, no cranes—but instead, complete flexibility to move billets, sheets, or slabs where they're needed—and while they're still hot!

One man handles up to 50,000 lbs. and can work almost anywhere in the mill. Manual handling is just about eliminated—service between mills is highly speeded up.

But the Clark-Ross Carrier not only gives faster, more flexible handling . . . it saves money too. As one example, Allegheny Ludlum's Brackenridge works reports an estimated annual saving of $11,000.00 in handling slab alone.

One man operation, self-loading, self-unloading, truck speeds, complete flexibility, heavy capacities are just some of the Carrier's features. It's why we say the Clark-Ross Carrier is a "natural" for the steel industry. Give your local Clark dealer a call and ask for details. He's listed in the Yellow pages under "Trucks, Industrial."

These tracks used to be in use until the flexible Carrier came along. Now the job is done faster, cheaper and without special equipment.

*Clark-Ross is a Trademark of Clark Equipment Company

CLARK® EQUIPMENT

ROSS CARRIER DIVISION
CLARK EQUIPMENT COMPANY
BATTLE CREEK 135, MICHIGAN
A BETTER BUY WITH LOCAL SUPPLY—*Genuine Clark Parts*

Morgan Quality in Action

MORGAN WORCESTER

High Speed Four Strand Rod Mill

Cuyahoga Works, American Steel and Wire Division

UNITED STATES STEEL CORPORATION

Morgan Mills are known to steel men throughout the world for their sound design and accurate manufacture . . . an enviable reputation which has assured mill users of efficient and trouble-free operation. Morgan Mills have kept pace with the ever-increasing demands for high output and greater accuracy of product.

MORGAN CONSTRUCTION CO.

WORCESTER, MASSACHUSETTS

ROLLING MILLS MORGOIL BEARINGS GAS PRODUCERS
WIRE MILLS EJECTORS REGENERATIVE FURNACE CONTROL

RM-70

MORGAN WORCESTER MORGAN WORCESTER MORGAN WORCESTER MORGAN WORCESTER MORGAN WORCESTER MORGAN WORCESTER MORGAN WORCESTER MORGAN WORCESTER

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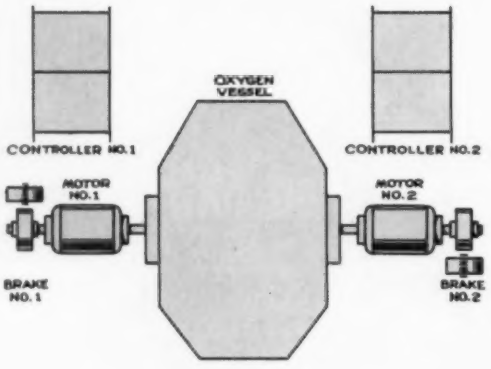
ANOTHER FIRST BY EC&M...

Installation Photos, courtesy of McLouth Steel Corporation.



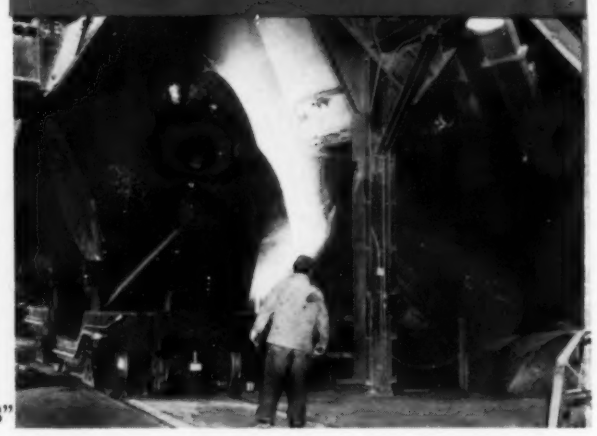
STEEL IN MINUTES FROM SCRAP AND HOT METAL

Photo "A" shows the scrap car charging scrap into the tilted oxygen vessel. The hoppers on these cars are also used for carrying other additives to the converter. When charging Hot Metal, as in Photo "B", the ladle and the vessel are tilted in unison toward each other for accurate metal transfer.

All operations (tilt and propel) of these cars are EC&M Controlled. Propel motions are also equipped with EC&M Type WB Brakes.

The first Oxygen Converter installation in the United States was built by Pennsylvania Engineering Corp. and is EC&M controlled.

"A"



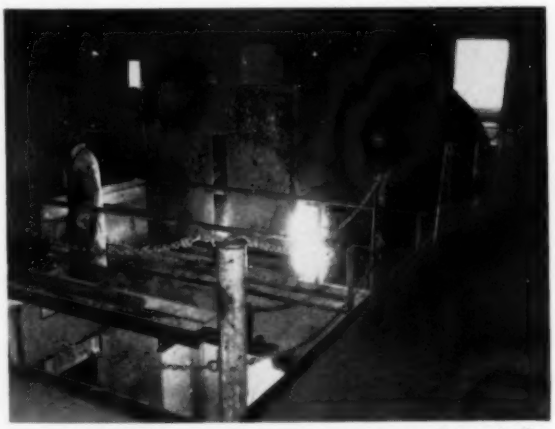
"B"

ELECTRIC MOTOR CONTROL FOR OXYGEN CONVERTERS

For simplicity and maximum safety . . . the scrap car, hot metal car and oxygen vessel tilt, shown here, are equipped with constant potential drives using series wound motors and series brakes.

EC&M Magnetic Controllers provide maximum dependability for all drives and maintain high production under the safest conditions.

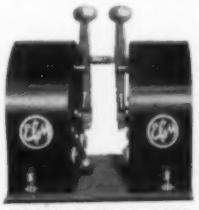
We invite you to discuss control for this newest hot metal application at your convenience. Call an EC&M engineer to learn the advantages of this safe, low-cost control for hot metal handling.



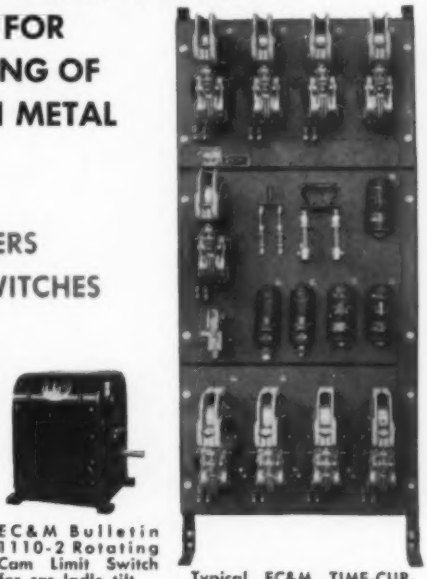
HOT METAL poured from converter vessel into ladle-car below. EC&M Control provides slow speed to avoid spills . . . to permit safe pouring speeds.

CONTROL APPARATUS WITH A REPUTATION FOR SAFE HANDLING OF HOT MOLTEN METAL

- 2 BRAKES
- 2 MOTORS
- 2 CONTROLLERS
- 2 MASTER SWITCHES



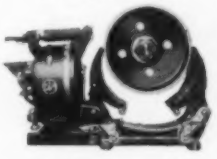
EC&M Bulletin 1190 Cam Master Switches, mechanically connected by quickly detachable coupling.



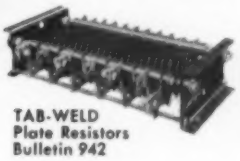
Typical EC&M TIME-CURRENT Controller for Hot Molten Metal Service. Of the Reversing-Plugging Type, with Armature shunt slow-down on first point.

EC&M Bulletin 1110-2 Rotating Cam Limit Switch for car-ladle tilt.

EC&M Bulletin 1110-1 Type E Limit Switch for car positioning.



EC&M Type WB Brake with 2 separate series windings, one for each motor circuit.



TAB-WELD Plate Resistors Bulletin 942

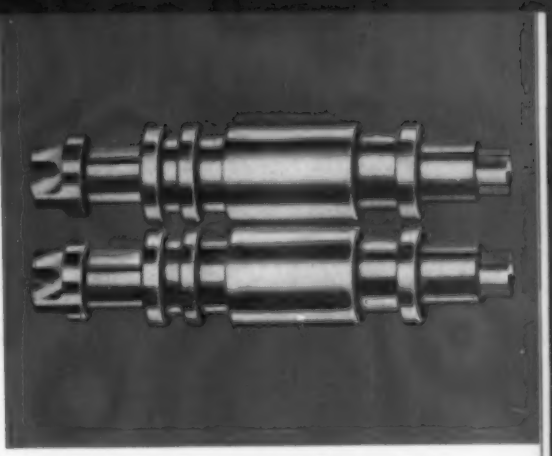
This EC&M Control System avoids dangerous spills, because each motor circuit is electrically independent, and separate controllers are operated from a double Master Switch with quickly detachable coupling. Should one motor fail . . . no knife, transfer or disconnect switches need be operated to continue operation with one motor.

SQUARE D COMPANY

EC&M DIVISION • CLEVELAND 28, OHIO

CONTINENTAL
CONTINENTAL

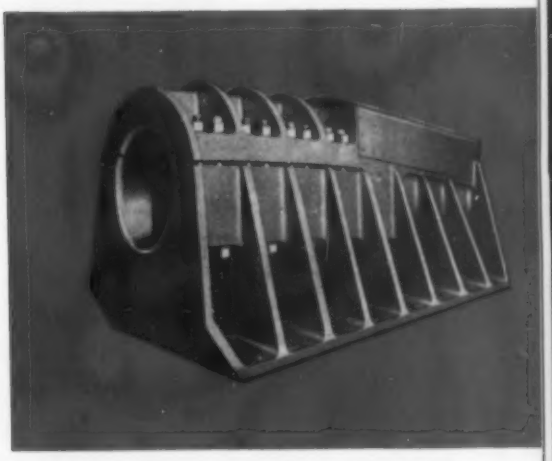
CONTINENTAL 40-inch, 2-high reversing blooming-slabbing mill in the Fairless Works of the United States Steel Corporation.



ROLLS—Iron, alloy iron and steel rolls for all types of rolling mills.

BLAW-KNOX

makes what it takes to handle tough blooming-slabbing operations

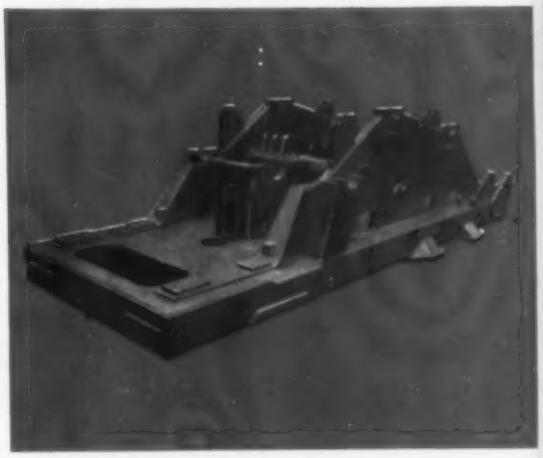


CASTINGS—carbon and alloy steel castings from 20 to 250,000 pounds.

In operation as an intermediate mill for subsequent rolling, this rugged Continental 40-inch reversing blooming-slabbing mill is providing excellent performance in the United States Steel's Fairless Works.

Variations of the basic design of this mill are built by Blaw-Knox to serve as break-down mills for billet and bar mills, rail and structural mills, and merchant mills.

Blaw-Knox designs and builds complete rolling mill installations—assumes undivided responsibility from preliminary engineering to satisfactory operation. At any time we'll be glad to discuss your plans with you.



WELDMENTS—fabricated steel plate, or cast-weld design.

50th Anniversary

BLAW-KNOX

1906-1956

CONTINENTAL Foundry & Machine

BLAW-KNOX COMPANY

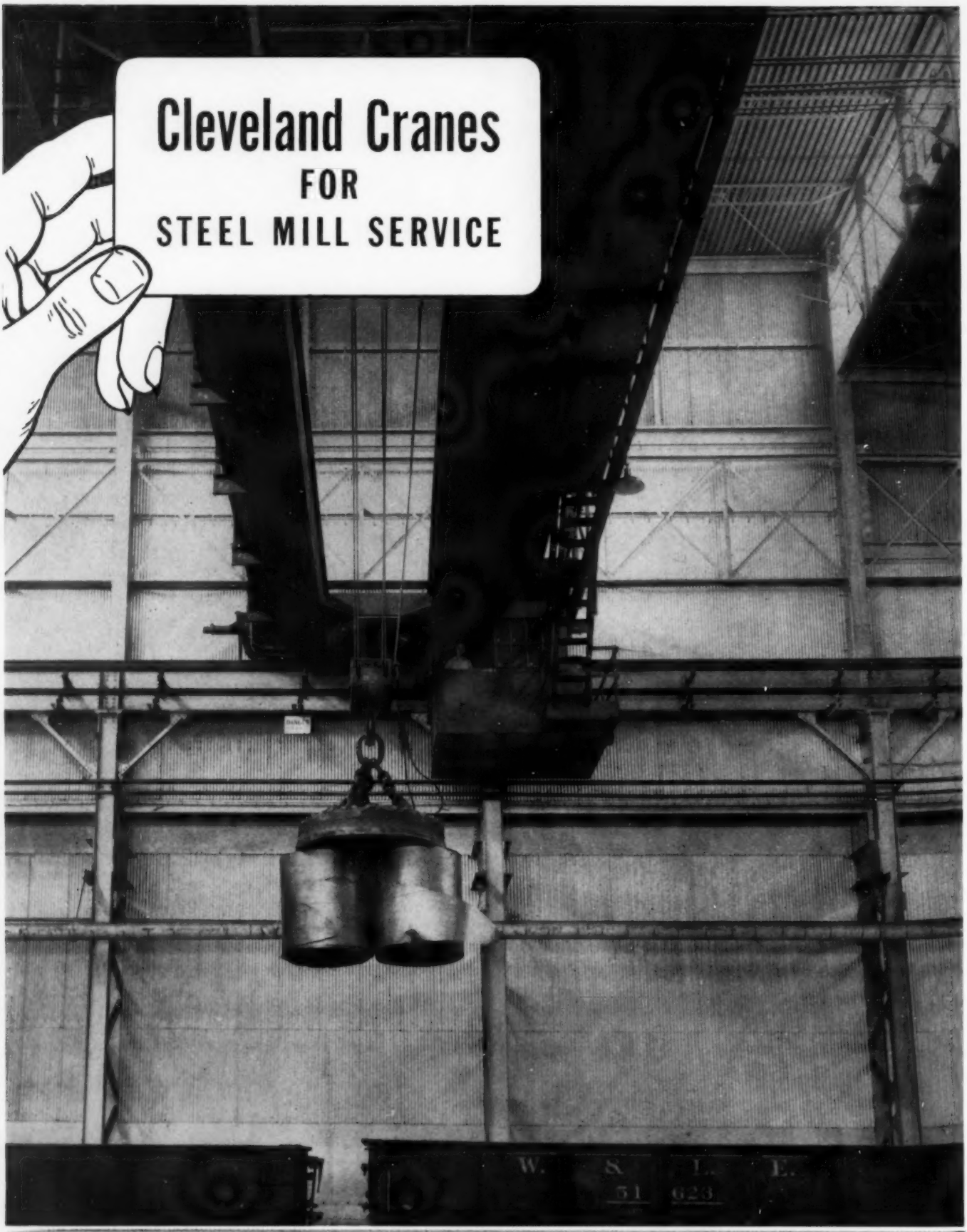
Foundry and Mill Machinery Division

Blaw-Knox Building • 300 Sixth Avenue

Pittsburgh 22, Pennsylvania

Complete Rolling Mill Installations . . . including all auxiliary equipment . . . for ferrous and non-ferrous metals

Hot strip mills • cold strip mills • slabbing mills • temper mills • universal mills • plate mills • blooming mills • structural mills • rail mills • billet mills • rod mills • merchant mills • roll lathes • chippers • special machinery • and complete auxiliary equipment



CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

5031 EAST 289th ST.
WICKLIFFE, OHIO

Crops *and* Shorts

FULL tilt operations for the steel industry are foreseen well into 1957. Steel production for 1956 is estimated at approximately 115,000,000 net tons of ingots and predictions for 1957 range 116,000,000-120,000,000 tons.

▲

STEEL users report that plate and structural steel are available from brokers at three to four times mill prices. Conversion deals are with us again, resulting in plate costs about twice the mill price.

▲

MANY women don't do a bit of laundry but they all use a clothes line — "I don't have a thing to wear."

▲

STEEL producers are voicing sentiments favoring higher prices. Many feel the $8.50 raise following the strike settlement is not adequate to cover increased costs. If steel wages go up two or three cents an hour in 1957 as a result of increased living costs, as well they might, some price increases are sure to follow.

▲

REMEMBER when they used to say the break-even point in the steel industry was around 80% of capacity operations? Third-quarter reports from steel producers, although badly affected by the 34-day strike, generally show some profits at operating rates of 60 per cent and even lower.

▲

FROM the Wall Street Journal:

Dear wife, desist from writing checks.
I voice this veto less to vex
Than state a fact there is no doubt of —
It isn't ink we're running out of.

▲

WE are about to start a new organization to be known as STASCIDOA. That stands for Society to Abolish Senseless Changes in Design of Automobiles. The object of the society will be to war against longer, wider cars that are making garages and roads obsolete, excessive horsepower that hogs gasoline, four headlights, 2-foot tail lights, rear fenders that look like stabilizers, road clearance that bogs you down on anything rougher than a pool table, glass tops that offer no protection in accidents, windshields that wrap around so completely you have to be a contortionist to get in and out, engines so buried that it's practically an excavation job to change spark plugs, and all the useless gadgets that run up cost and maintenance.

We believe this organization will grown like wildfire — there must be a lot of kindred souls who agree with us.

▲

ENGINEERS are now earning about 8.6 per cent more than they earned last year, according to an American Management Association survey. This compares to a 4.5 per cent increase for the previous year.

▲

QUOTE: "We expect the industry of 2056 will have moved all the way to a continuous operation instead of a batch-type process. Steel will be made by direct reduction of iron ore, using atomic energy. Iron ore will move in at one end of the plant and finished steel products will emerge at the other, without intermediate processes such as soaking, conditioning, hot rolling, annealing, pickling and shearing. Extruding will largely have replaced rolling to produce the finished products. Order entry, production planning, mill scheduling, cost control, and production and shipment records all will be handled by an interlocking computer system."

Utopia? Millennium? Just an excerpt from remarks by B. F. Fairless at the dedication of the Socony Mobil building in New York.

▲

THEY tell us a new question has crept into those psychological tests so much in vogue now. They give the name Monroe and you write down the first word you think of. They claim one man did write "doctrine" and another, "president."

▲

NO. 4 blast furnace of National Tube's McKeesport plant was blown out last month after a campaign of 9 years, 3 months and 3 days without relining or patching. The furnace produced 2,718,000 tons of iron in its 3380-day campaign, which included 161 days on bank. It has a 22½ ft hearth diameter and is rated at 884 tons per day.

▲

BLAST furnace slag, formerly a worthless nuisance, has become a $46,000,000 a year product. In 1955, a record 32,400,000 tons of blast furnace slag was processed into aggregate for concrete, mineral wool, track bed ballast, soil conditioners, etc. This processing has increased four-fold in the last 20 years.

▲

THE rank-and-file revolt in the United Steel Workers of America over the two-dollar hike in monthly union dues seems to be confined to the Pittsburgh area. It does not seem to be spreading and union officers apparently are not too worried.

▲

THIS is a nice quiet time of the year. Elections are over, football is about ended, grass cutting is finished, snow shoveling not yet here, Christmas season (in spite of misdirected efforts of merchants) is yet to come, and all we have to do is look for a nice peaceful Thanksgiving Day.

How to spend less for expendables

Day after day, week after week, your instruments steadily use up charts, inks, thermocouple wires, tubes, wells—all the expendable accessories that require regular replacement.

If you've been buying your supplies on a hand-to-mouth basis, you're missing out on some sizable savings. Honeywell has developed a modern purchasing plan that gives you new economy, convenience, and quality. This new plan provides assistance in selecting the right supplies and sets up a custom-fitted schedule for buying that will cut your inventories, simplify your purchasing, and save you a big percentage of your annual bill.

New HSM Plan

Foundation of this new plan is your Honeywell Supplies Man. He is trained in the Honeywell factory and has a broad and thorough knowledge of instrumentation. A full-time supplies specialist, your HSM gives you personalized, expert service.

These men are strategically stationed throughout the country to serve you. They will help you plan your purchases to get maximum quantity discounts . . . keep your inventories balanced and always up to date.

Here's how the plan works

1. ***Survey plant***—Your Honeywell Supplies Man checks annual consumption of each supply item in your plant and establishes minimum inventory needs.
2. ***Detail requirements***—He then shows you what you can expect to purchase during the coming year to keep adequate stocks on your shelves.
3. ***Assist in selection***—He keeps you up to date on newest developments, and recommends specific types of equipment wherever your present buying can be improved.
4. ***Estimate savings***—Next, he prepares a blanket annual order, grouping like items to get the biggest quantity discount. Savings may run as high as 50%.
5. ***Schedule deliveries***—Finally, he arranges a regular delivery schedule that assures that you will always have adequate supplies on hand.

Give your Honeywell Supplies Man a call. He's at your local Honeywell office . . . as near as your phone.

Waste gases recirculated, pit operations improved at

An evenly heated ingot is withdrawn from a Honeywell-controlled soaking pit furnace at U. S. Steel's Fairless Works.

Two indices on the ElectroniK instrument permit controlled heat acceleration cycles.

Fairless...by *ElectroniK* controls

Soaking pit instrumentation by Honeywell is paying off at U.S. Steel's Fairless Works near Morrisville, Pa. An *ElectroniK* strip chart controller with *Electr-O-Line* control unit regulates the recirculation of hot waste gases from soaking pit furnaces supplied by Loftus Engineering Corporation. With waste gases at work together with fuel gas, the volume of gases flowing through the pits is maintained at a relatively constant level. Results: better distribution and use of heat, less soaking time.

Recirculation of waste gases occurs as pit temperature reaches the control point. The operator switches a manual reset control unit into the system, opening the waste gas valve proportionately over a 30 percent band as the fuel gas valve starts to close.

Honeywell instrumentation gives Fairless another major advantage: *heat acceleration*—the temporary elevation of pit temperature to a higher-than-normal limit for extra-fast heating of ingots. The *ElectroniK* controller has two indices which are normally set about 50 degrees apart. During normal operations, temperature is held at the lower index. To accelerate heating, the operator sets a timer, then pushes a button. Immediately, the fuel gas valve opens and the upper index takes over control. At the end of the timed cycle, control reverts to the lower index.

In your own plant, versatile Honeywell instrumentation can make profitable improvements in processes and products. Find out how from your nearest Honeywell sales engineer. He's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

● **REFERENCE DATA:** Write for Catalog 1531—"*ElectroniK* Controllers".

H HONEYWELL

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls

Two Separate Circuits Mean

Reliable Rectifier Operation

ALLIS-CHALMERS

Mercury Arc Rectifiers

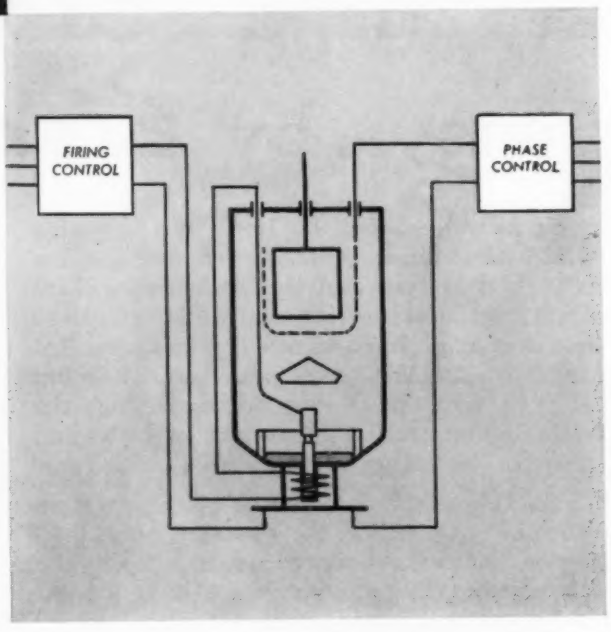
One of four metal-enclosed assemblies in a midwestern installation with a total capacity of 15,000 kw at 620 volts, dc.

1. Firing Circuit

A small dc excitation arc is automatically ignited only once, when the unit is started. It is then maintained on the mercury cathode of each rectifier tube. It offers advantages similar to a pilot light. Since it is far easier to maintain an arc than to start it, this feature reduces the chance of the excitron losing excitation during power supply disturbances.

2. Phase Control Circuit

A separate circuit utilizes the deionizing grid to obtain phase control. Grid-type phase control permits operation in the clean region near the anode where ion density is lowest, instead of on the surface of the cathode mercury pool where there is turbulence and contamination. Reliability of phase control does not depend on the condition of the mercury. This is an exclusive excitron feature.



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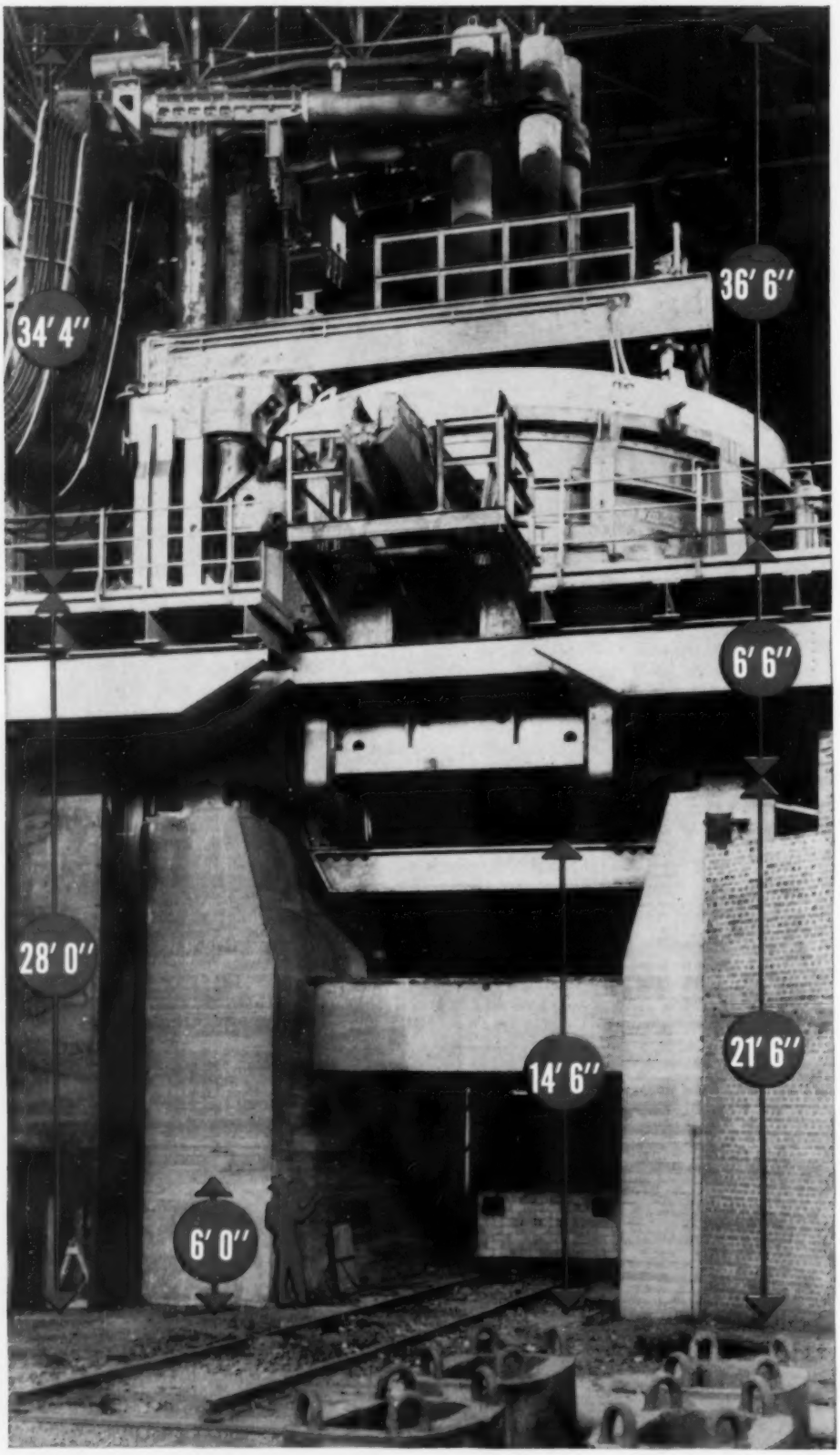

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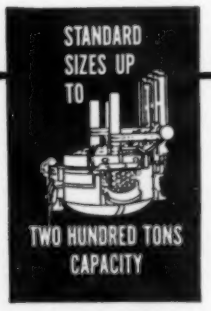

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WHEN YOU MELT... *Lectromelt*

By H. J. ROHM, General Coordinator, Fuel and Power, United States Steel Corp., Pittsburgh, Pa.

Local and Interplant Gas Dispatching for Steel Plants

To obtain the most economical distribution and use of fuel and power in a steel plant, central control and operation are necessary . . . . telemetering systems inform operators of conditions throughout the plant.

▲ THE distribution of by-product and purchased gaseous fuels, and the usage of liquid and solid fuels and purchased power, present many varied problems in the plants of the United States Steel Corp. in the Chicago and Pittsburgh Districts. In the Chicago district there are three plants interconnected by a gaseous fuel system and six plants interconnected by the district 25 and 60-cycle electric power systems. In the Pittsburgh district there are six plants interconnected by a gaseous fuel system and seven plants interconnected by the district 25 and 60-cycle electric power systems.

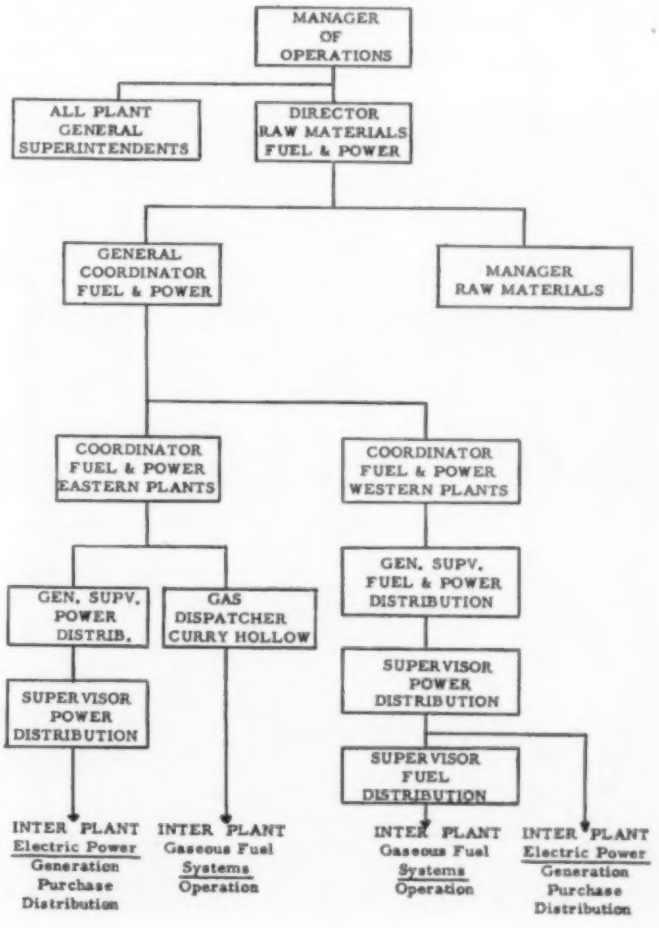
The distribution of blast furnace gas in the two integrated steel plants, the South Chicago plant and Gary Steel Works deviates somewhat from the normal distribution encountered in an integrated steel plant. Normal distribution provides for blast furnace stove requirements, blast furnace blowing requirements, with the balance used under boilers for providing the necessary plant process steam requirements and for generating electrical power.

In addition to supplying the above-mentioned requirements the distribution of blast furnace gas at the South Chicago plant provides for a supply to soaking pits, a number of reheating furnaces and gas engine-driven electric power generators. The distribution of blast furnace gas at Gary Steel Works provides for a supply to gas engine-driven electric power generators and to the coke plant for underfiring ovens. The operation of this system is controlled by the district organization in close cooperation with Gary Works' power and fuel department.

Sixteen coke oven batteries are installed at the Gary coke plant and ten of these are equipped for underfiring with blast furnace gas. Plans are to equip two more batteries for blast furnace gas underfiring, making a total of twelve. With twelve batteries underfired with blast furnace gas there will be 60,000,000 cu ft per day of coke oven gas, over and above the normal surplus gas, released for metallurgical purposes.

Prior to 1933, the South Chicago plant used the normal organization in the control of pressures and distribution of blast furnace gas. The blast furnace department controlled this operation through the position of a "Gas Pressure Operator." With the extension of the blast furnace gas distribution system to include usage at soaking pits, it was necessary that

Figure 1 — U. S. Steel's organization for operating the fuel and power systems are given by this chart for the Pittsburgh and Chicago districts.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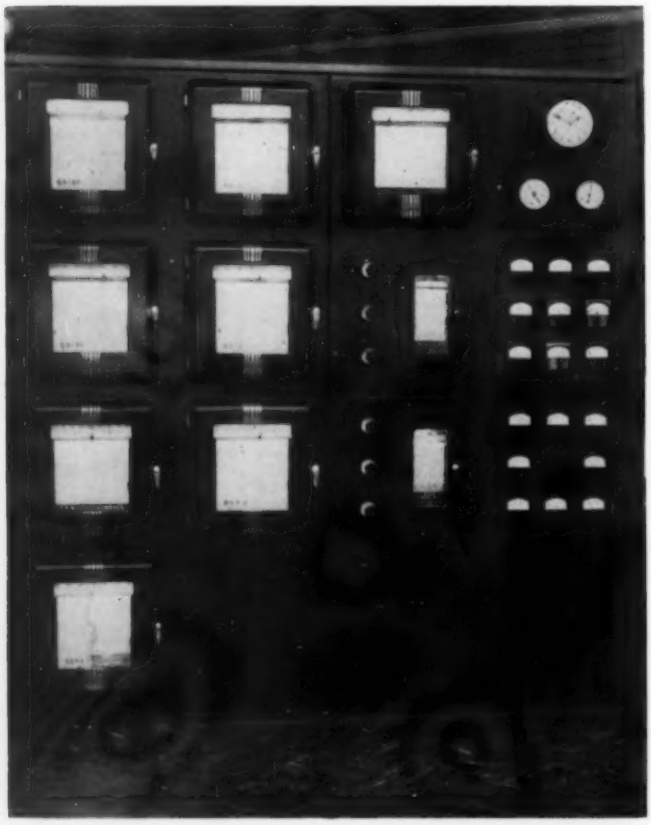
SUPERVISOR POWER DISTRIBUTION
SUPERVISOR FUEL DISTRIBUTION
INTER PLANT Electric Power Generation Purchase Distribution
INTER PLANT Gaseous Fuel Systems Operation
INTER PLANT Gaseous Fuel Systems Operation
INTER PLANT Electric Power Generation Purchase Distribution

Figure 2 — Telemetering charts are essential in operating the system.

closer control and distribution be maintained and a position of "Fuel Dispatcher" was established. This position was under the control of the electrical department until 1938, when the power production department was established with responsibility for all fuel distribution and power production. This plant is connected with the district 25 and 60-cycle power systems, generating electric power of both frequencies, and usage of fuels is largely affected by district operations.

Figure 1 shows briefly the supervisory organization for operation of the Chicago and Pittsburgh districts gaseous fuel and electric power interplant systems.

Figure 3 — Telemetering system is also installed for the 25-cycle power generation and distribution at the Gary Works.



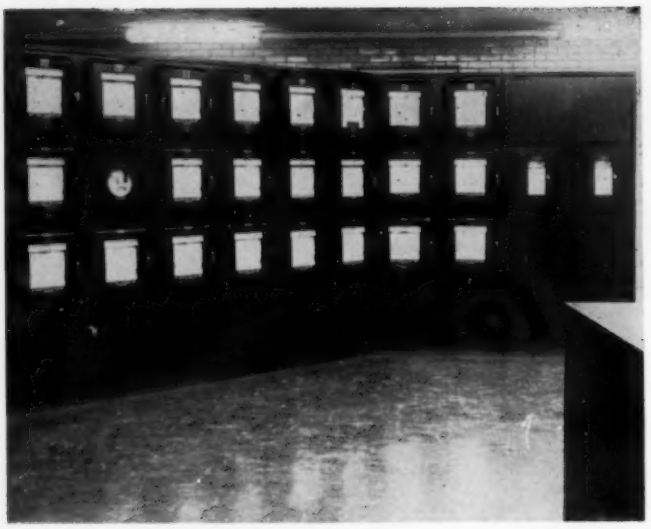


Figure 4 — Control of the 60-cycle interplant system is also helped by telemetering installation.

In each district there is a coordinator of fuel and power who is in the employ of the Pittsburgh office and independent of any plant. Each district has its organization under the supervision of the coordinator. These men have definite line responsibilities and function in a staff capacity for other fuel and power operations. The Chicago district organization is located at the Gary Steel plant while the Pittsburgh district organization is located at two different locations, Duquesne Steel Works and Curry Hollow Gas Mixing Station. The ideal organization is that in the Chicago district where all interplant gaseous fuel and electric power distribution is telemetered into one dispatching office. Definite advantages are apparent when fuel and electric power are dispatched from one office. Each dispatcher's meters are an aid to the other in analyzing operation trends and anticipating future changes. Information can be exchanged freely and very little duplication of records exists. In times of emergencies, one can recognize these advantages by being present and watching the dispatchers operate.

Figure 2 shows the coke oven gas and blast furnace gas telemetering installed in the Chicago district office at Gary Steel Works. To the left on this figure the first five vertical rows show coke oven gas meters for flow, pressure and holder position. The next five vertical rows of meters are for blast furnace gas pressure, and flow, and holder and bleeder positions. In the center of this panel is the supervisory control for remotely starting and stopping boosters for supplying blast furnace gas to the tertiary cleaned blast furnace gas system for coke oven underfiring. The three vertical rows at the extreme right meter steam production, flow, and pressures for Gary Steel Works.

Figure 3 shows the 25-cycle telemetering for electric power generation and flow in Gary Works.

Figure 4 shows the 60-cycle telemetering for generation, purchase, and distribution on the district 60-cycle interplant systems.

As stated previously, blast furnace gas at the South Works is controlled by the organization in that plant. However, the consumption of this fuel for steam and electric power generation ties this fuel system into the district through the medium of electric power. Blast

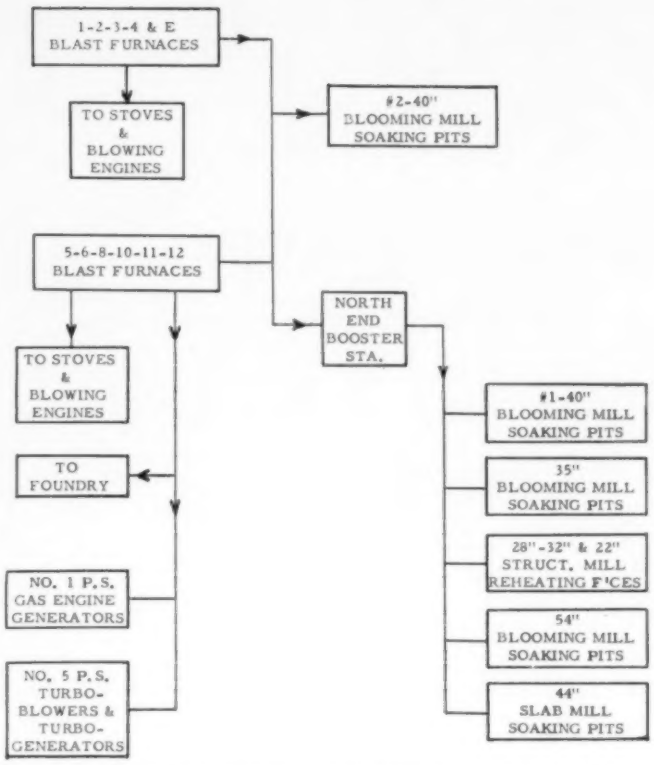

1-2-3-4 & E BLAST FURNACES
TO STOVES & BLOWING ENGINES
#2-40" BLOOMING MILL SOAKING PITS
5-6-8-10-11-12 BLAST FURNACES
NORTH END BOOSTER STA.
TO STOVES & BLOWING ENGINES
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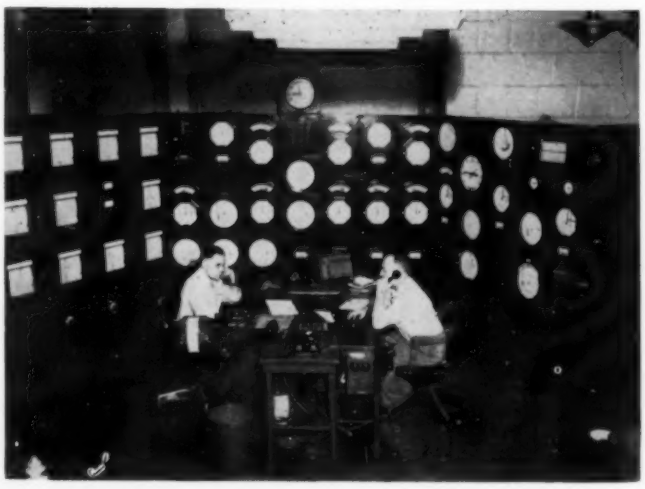
Figure 5 — Single line diagram of blast furnace gas system at South Works.

furnace gas, natural gas and fuel oil are used in the South Works' plant for generation of steam and electric power.

Figure 5 is a single line diagram of the South Works' blast furnace gas system showing the two furnace groups with connecting and distribution mains.

Figure 6 shows the electric power, blast furnace gas, natural gas and steam telemetering located at South Works covering distribution and pressures. The South Works' dispatching organization keeps the district organization informed at all times through the interplant telephone system of any changes in their own fuel operations. This allows proper interlocking of this plant's operation, through the electric power systems, with the fuel conditions in the plants comprising the Gary district.

Figure 6 — South Works dispatching organization keeps the district informed at all times over the interplant telephone system.



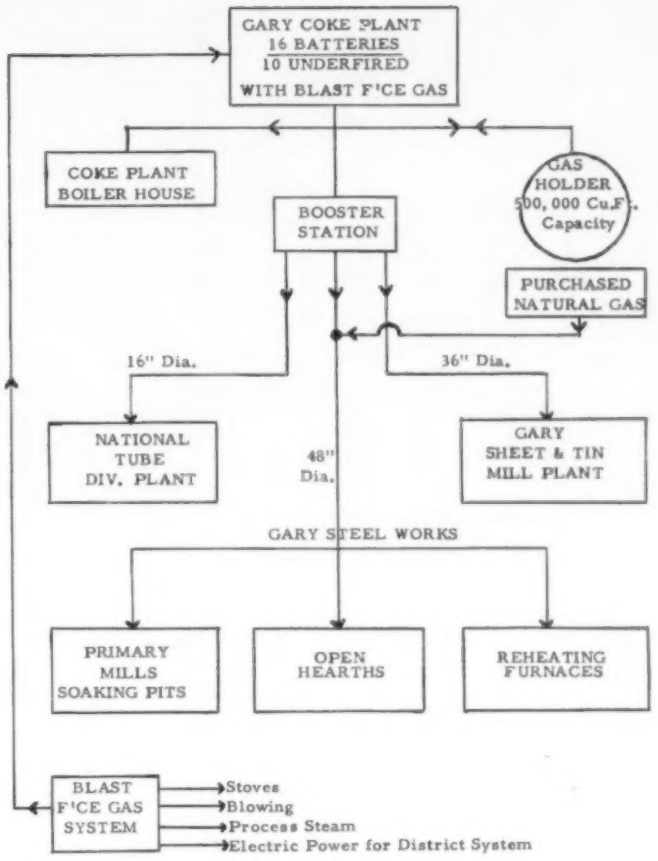


Figure 7 — Single line diagram of Gary district coke oven gas system.

Figure 7 is a single line diagram of the coke oven gas system in the Gary district, which serves the Gary Steel Works, Gary Sheet and Tin Mill and National Tube Division plant. All coke oven gas is boosted to 10-psig at the booster station with the exception of gas used at the coke plant boiler house. Boosted gas is supplied to Gary Steel Works through a 48-in. diam underground main, approximately one mile long, when it then enters the plant system supplying the various mills and open hearths. A 36-in. underground main approximately 2½ miles long is used to supply boosted gas to the Gary Sheet and Tin Mill. A 16-in. underground main approximately ½ mile long supplies boosted gas to the National Tube Division plant.

There are four boosters in the booster station, two steam turbine driven compressors, one 25-cycle driven compressor, and one 60-cycle driven compressor. Each has a rated capacity of 67,680,000 cu ft per day at 10-psig delivery pressure. Likelihood of a severe disruption in the continuity of the boosted gas supply is minimized by the fact that complete reliance is not placed on electric power and further by the fact that the electric power source is not limited to one frequency. With nine batteries being under fired with blast furnace gas, the boosters are averaging about 165,000,000 cu ft of coke oven gas per day total output.

Purchased natural gas is used to a certain extent in conjunction with the boosted coke oven gas system. This natural gas is introduced immediately on the downstream side of the booster station where the 48-in. main starts for Gary Steel Works. The regulation or use of natural gas is controlled remotely from the

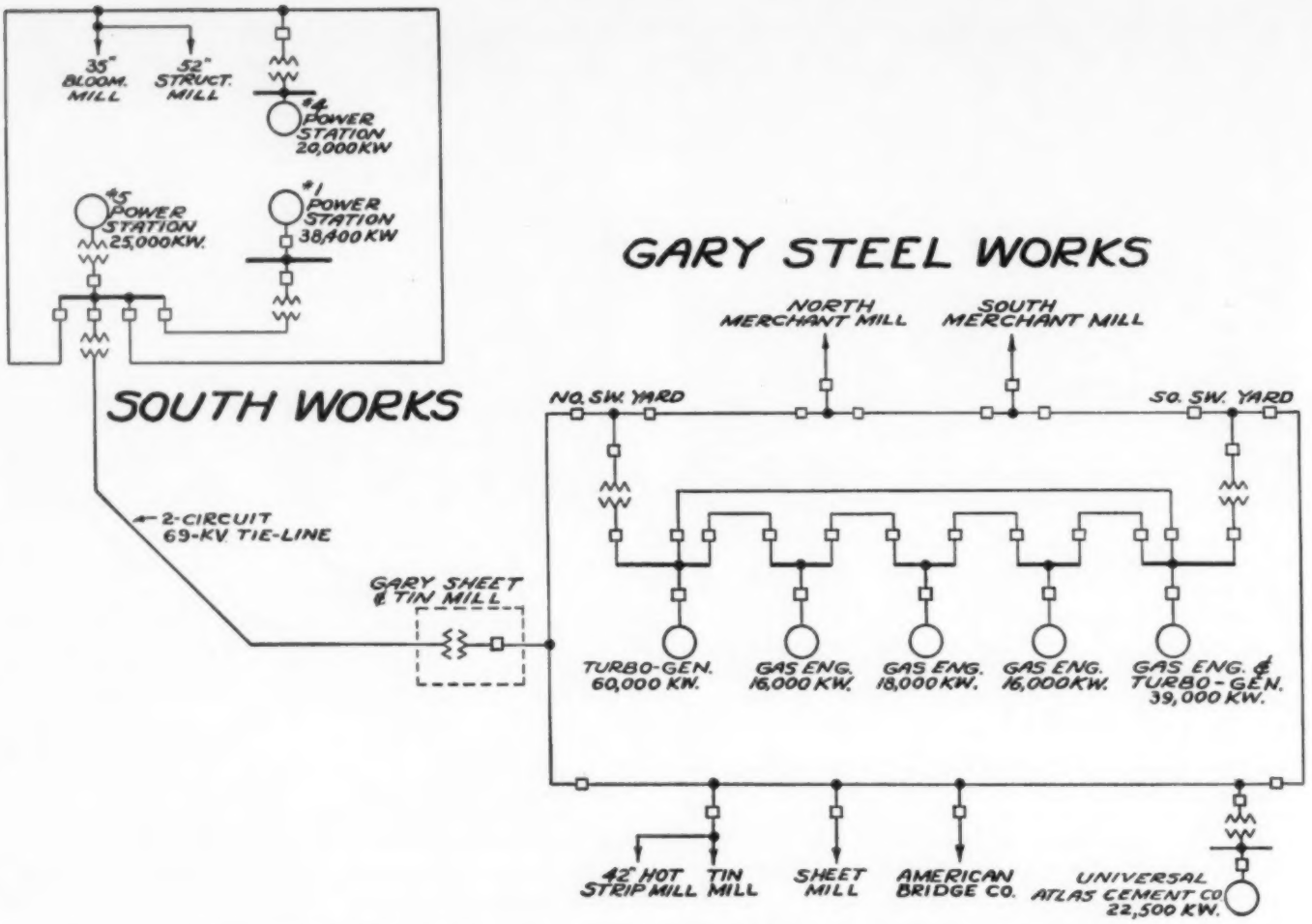


Figure 8 — Single line diagram of Chicago district 25-cycle interplant power system.

district dispatching office. From zero to 4,000,000 cu ft per day of natural gas is fed into the 48-in. main going to Gary Steel Works. This feed-in is used primarily to control the gas holder position and to lessen the number of necessary changes in open hearth and/or reheating furnace consumption in the course of equaling total demand to supply.

Purchased natural gas is used in the Chicago district plants for many different purposes. At South Works, firm industrial natural gas is used for boiler pilots, bleeder pilots, and other small miscellaneous uses where firm gas is necessary. Interruptible process natural gas is used by open hearths for about 30 per cent of their total fuel requirements, by soaking pits for enriching blast furnace gas, and by reheating furnaces for practically all of their fuel requirements. Other small consumers make up the balance of this type of gas consumption. Interruptible boiler natural gas, when available, is used at the South Works' No. 5 power station as a supplement to blast furnace gas when the supply of blast furnace gas is insufficient to meet the boiler load requirements.

Firm industrial natural gas is used in small quantities at the Gary Sheet and Tin Mill for special processes where a clean gas is necessary. Firm industrial natural gas is used in small quantity by the National Tube Division plant for special process work, and, as stated previously, natural gas is used at Gary Steel Works in conjunction with the coke oven gas system. The plants comprising the Chicago district connected to interplant gaseous fuel and electric power systems will use an average of 35 to 40,000,000 cu ft of purchased natural gas per day, depending on load conditions and its availability.

Pitch-tar mix is used by two open hearths at Gary Steel in conjunction with coke oven gas. All other open hearth furnaces at Gary Steel Works use No. 6 heavy fuel oil in conjunction with coke oven gas. At South Works, the open hearths use No. 6 heavy fuel oil in conjunction with natural gas. All soaking pits and reheating furnaces are using gaseous fuel, either blast furnace gas enriched with natural gas, straight natural gas, straight coke oven gas, or a mixture of coke oven and natural gas with one exception. The 80-in. mill reheating furnaces at the Gary Sheet and Tin Mill use coke oven gas and No. 6 heavy fuel oil to give them certain heating and production benefits.

From the foregoing it is evident that the fuel systems, as described, are very complex and many problems arise due to insufficient fuel of a certain type, lack of flexibility in equipment to obtain proper distribution, and varying load conditions. In order to complicate things a little more, 60-cycle electric power is purchased from the public utility in the Gary district and our interplant 60-cycle electric power system is operated in parallel with their system. Electric power at 25-cycles is generated at South Works, Gary Steel Works and the Buffington plant of the Universal Atlas Cement Co., and 60-cycle electric power is generated as South Works. All this is transmitted to the Gary

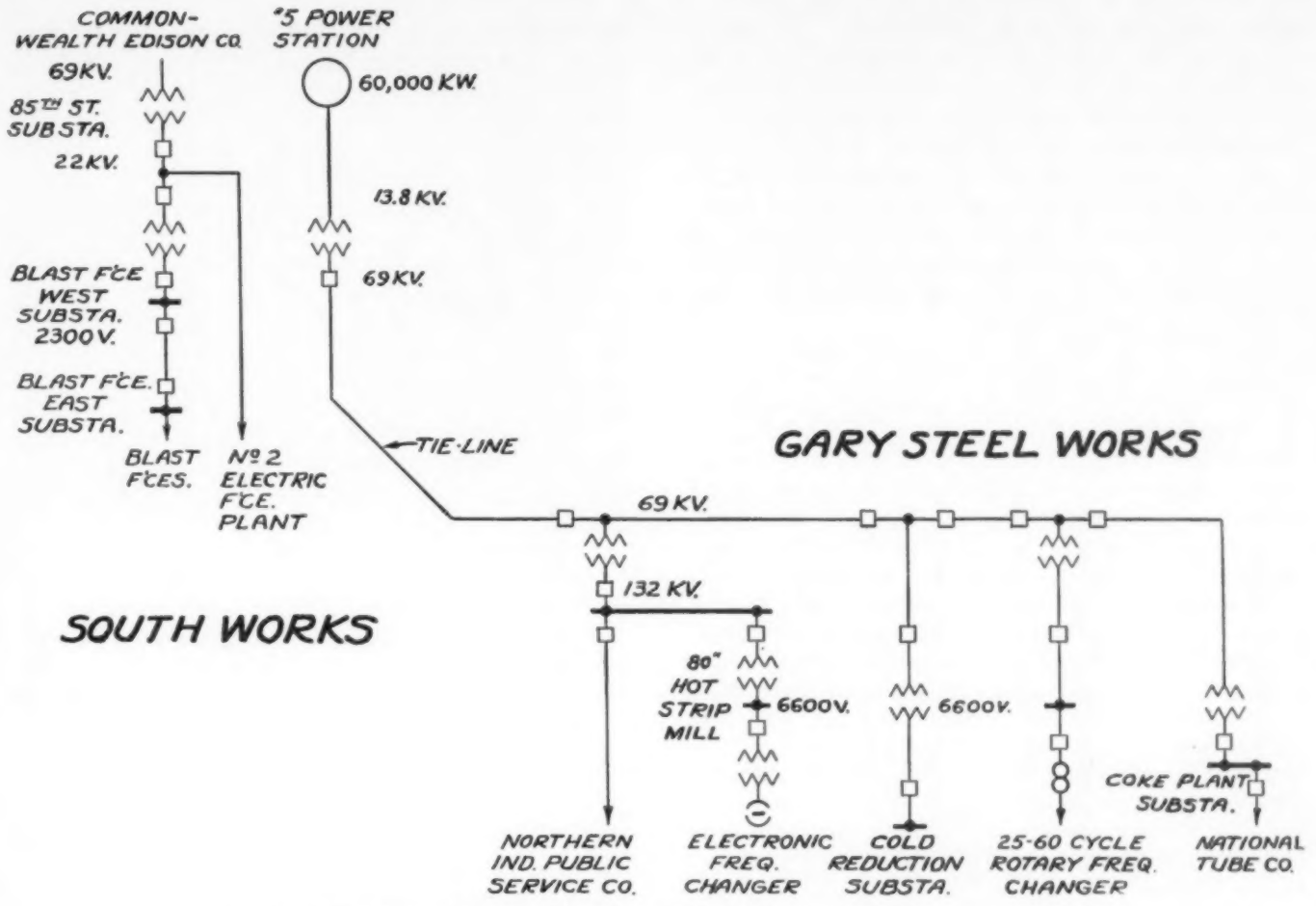


Figure 9 — Single line diagram of Chicago district 60-cycle interplant power system.

district for consumption. The 25-cycle and 60-cycle electric power systems are interconnected through two electronic frequency changers of 8000 kw capacity each, and one rotary frequency changer of 10,500 kw capacity. The number of coke oven batteries which are to be underfired with blast furnace gas at Gary Steel Works coke plant is governed in part by blast furnace gas conditions at both South and Gary Works, availability of purchased natural gas and 60-cycle electric power. No. 6 heavy fuel oil is used under boilers at both these plants when blast furnace gas and/or purchased natural gas is not available in sufficient quantities. The usage of this liquid fuel ties in very closely with operating conditions in the purchase of 60-cycle electric power.

Figure 8 is a single line diagram of the Chicago district interplant 25-cycle power system showing generating stations, switchyards, and interconnecting transmission lines.

Figure 9 is a single line diagram of the Chicago district interplant 60-cycle power system showing the generating station at South Works, switchyards and substations in the Gary area, and interconnecting transmission lines. A considerable amount of 25-cycle electric power is still generated by gas engines using only blast furnace gas. Operation of a certain amount of these units to meet the district electric power requirements requires the diversion of blast furnace gas from boilers, which in turn results in using purchased natural gas and/or fuel oil under boilers or buying additional 60-cycle electric power from the public utility.

Previously it was stated that Gary coke plant boiler house used unboosted coke oven gas. Normally this boiler house uses coke breeze, and coke oven gas is used only in emergencies or when it is available, especially on week-ends and summer weekdays. Any coke breeze not used in this manner is either stocked for future use or sold to the outside trade. This is one means of conservation of gaseous fuels during light load periods. All operations in the Chicago district are planned in advance. Load requirements are obtained, by-product fuel availability is determined, and distribution problems are studied to obtain maximum usage of by-product fuels in the most economic manner. Purchased gaseous fuel and liquid fuel availability must be recognized in conjunction with purchased power availability. The dispatchers working turns are made fully aware of operations desired and should changes be necessary, they are thoroughly schooled in the proper changes to be made to meet the varying conditions in the most economic manner.

Mill scheduling is very important in obtaining the most efficient operations and maximum usage of by-product fuels. Of course we all know the mills have their problems too, such as orders, steel availability, and satisfying industrial relation problems. Each plant management is kept aware of the desired scheduling from a fuel and power standpoint and efforts are made to meet these ideal operations.

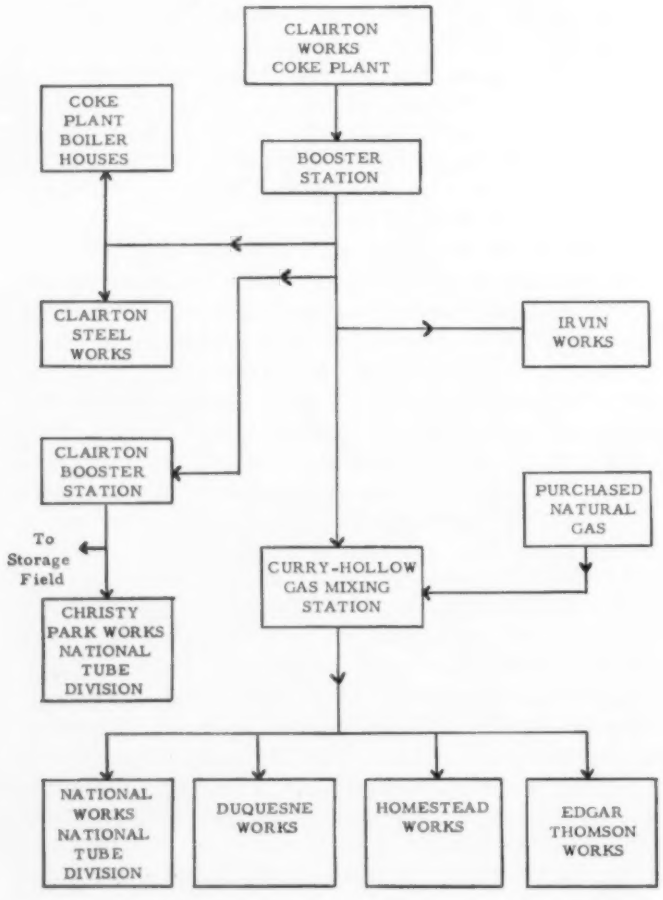
Dispatching of a district nature in the Chicago district was first started in 1943, and since that time the organization has been built up to meet the require-

ments. Telemetering was first installed at South Works in 1938 for this individual plant. Telemetering for the Chicago district was started in 1946, and has been improved since that time. Future plans call for more telemetering for this district office.

In the Pittsburgh district, as previously stated, the district dispatching offices are located in two places. The gaseous fuel dispatching office is located at the Curry Hollow gas mixing station near Irvin Works. The district electric power systems dispatching office is located at Duquesne Works.

Figure 10 is a single line diagram of the Pittsburgh district coke oven gas system. Coke oven gas is boosted at the Clairton coke works and transmitted throughout the Monongahela river valley to six plants of the corporation. The first coke oven gas mains for interplant distribution were installed in 1918, and are approximately 13 miles in length. In 1927, a second distribution system was installed paralleling the first system. Gas is boosted to 14-psig at the booster station at Clairton and is transmitted to the Curry Hollow gas mixing station through 40 and 48-in. diam mains. Clairton steel plant and boiler houses use straight coke oven gas. Irvin Works takes gas off before Curry Hollow and uses only straight coke oven gas. All other plants in the valley operate from the mixed gas system. At Curry Hollow the coke oven gas system is connected with the natural gas system of Carnegie Natural Gas Co. Natural gas is mixed in with coke oven gas and transmitted on down the river to Duquesne Works, Edgar Thomson Works, Homestead Works and National Works of the National Tube Division. The coke oven gas coming from Clairton averages about 580 Btu per cu ft. Natural gas is mixed in at Curry Hollow for pressure boosting primarily to maintain minimum pressures at the down river plants. Total coke oven gas boosted at Clairton averages approximately 175,000,000 cu ft per day. There are nine boosters available, all of which are steam driven. The rated capacity of each booster is 70,000,000 cu ft per day at a discharge pressure of 7-psig. The coke oven gas is boosted to 14-psig in two stages of compression. Coke oven gas passing through the Curry Hollow gas mixing station averages about 100,000,000 cu ft per day. To this is added an approximate average of 5,000,000 cu ft per day of natural gas. The amount of natural gas added is governed by operating conditions of the down river plants and will vary from zero to as high as 25,000,000 cu ft per day, these variations taking place hourly. The Btu per cu ft in the mixed gas will vary from 580 to as high as 800 Btu depending on the amount of natural gas added. Mixed gas is used on soaking pits and reheating furnaces. Straight natural gas is used for open hearth fuel in varying percentage of total fuel requirements at the various open hearth shops. This gas is obtained direct from the natural gas system of the Carnegie Natural Gas Co. and Equitable Gas Co.

Figure 10 — Single line diagram of coke oven gas system in Pittsburgh district.



Blast furnace gas produced at the various plants is used for stoves, blowing engines, and steam generation for turbo-blowers, turbo-generators, and plant process requirements. No blast furnace gas is used for soaking pits or reheating furnaces or underfiring coke oven batteries. Secondary fuel on all boilers is steam coal with exception of Clairton. At the coke works they use coke breeze to the maximum of its availability and supplement this with coal when necessary to meet load conditions. Coke oven gas is used on these boilers when not required at other plants for metallurgical purposes, primarily on week-ends, and coal is cut back and coke breeze is stocked for future use. No coke oven gas is used on boilers when natural gas is being mixed at Curry Hollow gas mixing station.

In previous years on this gaseous fuel system it was the practice to pump any surplus coke oven gas into the old natural gas field in the neighborhood of McKeesport for storage purposes. Coke oven gas pumped into the storage field when taken out later would pick up about 2 to 3 additional Btu per cu ft and some of the sulphur was left. A compressor with a daily capacity of 20,000,000 cu ft per day at 125-psig was used to pump the coke oven gas into the storage field. The amount pumped into the storage field in the past several years has been decreasing steadily due to rock pressures building up as a result of the field's inability to take more gas. Wells have become contaminated and cleaning cannot be accomplished due to their location in a growing domestic community. During the past year no pumping into storage has been done and only the gas the storage system will give up has been taken out. Eventually the field will be abandoned.

The electric power systems in the Pittsburgh district operate in much the same manner as those in the Chicago district. The 25-cycle interplant system receives generation from five plants and distributes to these five plants plus two additional. The 60-cycle in-

Figure 11 — At the Duquesne Works the original telemetering equipment, first installed in 1931, has just been replaced with modern meters.

terplant electrical system receives generation from one plant and the public utility and distributes to three plants. The two electric systems are interconnected through two electronic frequency-changers of 10,000 kw capacity each. Coke oven gas can be used for 25-cycle power generation at two of the plants to reduce coal burning at other plants when surplus coke oven gas is available for such uses.

The two electrical systems are not quite as closely connected with the gaseous fuel systems as in Chicago and do not present the complex operating problems to be met in the Chicago district.

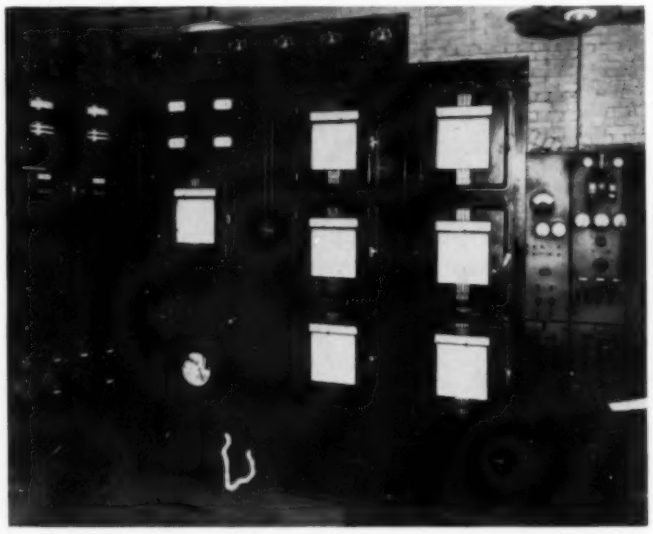
A new coke oven gas telemetering board was recently installed at the Curry Hollow gas mixing station. In the past it was not possible to tell what a plant was consuming unless a call was made to that plant and a man sent out to read the flow meter measuring total flow into the plant. This method of dispatching has always presented many problems and poor operations often resulted due to improper communication to the central dispatching point. We expect, with the installation of these meters to operate more efficiently and economically. We know from past experience at South Works, Gary Works, and the Chicago district that systems can be operated much tighter when proper communication, in the way of telemetering, has been installed at a central point. Particularly during emergencies have the central telemetering of gaseous fuels and electric power paid much toward their installation cost in preventing damage to equipment by allowing closer control and quicker action.

Figure 11 shows the telemetering of electric power for the 25-cycle electric power system at Duquesne Works. This telemetering was first installed in 1931, and just lately new telemetering cable has been installed and present metering is being replaced by modern meters.

Figure 12 shows the telemetering for the 60-cycle electric power system located at Duquesne Works and in addition the supervisory control for the high voltage substations on the system.

Our repeated references to the 25 and 60-cycle electric power systems in each district was deemed necessary in order to give a complete description of gas dispatching as practiced by the United States Steel Corp.

Figure 12 — Telemetering installation for the 60-cycle power system at the Duquesne Works.



DISCUSSION

PRESENTED BY

H. B. HELM, Fuel Engineer, Youngstown Sheet & Tube Co., East Chicago, Ind.

H. J. ROHM, General Coordinator, Fuel and Power, United States Steel Corp., Pittsburgh, Pa.

H. L. HALSTEAD, Assistant Fuel Engineer, Bethlehem Steel Corp., Sparrows Point, Md.

R. A. LAMBERT, Superintendent, Steam and Combustion, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

F. C. McGOUGH, Superintendent, Power & Fuel, Detroit Steel Corp., Portsmouth Works, Portsmouth, Ohio.

H. B. Helm: I gather from Mr. Rohm's comments that the open hearth department is used to help balance gas consumption with production. It is used on week-ends only or is it used during the week as well?

H. J. Rohm: There are five open hearth shops at Gary Steel Works plant. Two of these open hearth shops are using coke oven gas and pitch oil blend and the coke oven gas on these shops is not varied, only in extreme emergencies, for the purpose of regulating the coke oven gas system. The coke oven gas used by the other three open hearth shops is regulated whenever necessary, seven days per week, to meet the varying conditions on the coke oven gas system.

During the past several years we have tried to eliminate changes in open hearth gas consumption on the open hearth shops, for system regulation purposes, by dumping varying amounts of natural gas into the coke oven gas system.

H. L. Halstead: I inferred from Mr. Rohm's paper that, unlike the practice at some of the other steel plants, he dumps straight natural gas into the coke oven gas system and does not add either air or blast

furnace gas when adding natural gas.

H. J. Rohm: Yes, that is correct. In the Pittsburgh district, natural gas is fed into the coke oven gas system to aid in maintaining minimum operating pressures. The Btu in the mixed gas system will vary from a minimum of 580 to a maximum of approximately 800. In 1952 natural gas was brought into the Gary Steel Works plant and is currently being fed into the coke oven gas system, in varying amounts, to aid in stabilizing pressures. The Btu on this system will vary from approximately 520 to 540.

R. A. Lambert: In both the Pittsburgh district and the Chicago district, can you tell us what percentage of your total power consumption is purchased power? Does your gas dispatcher have any responsibility as to controlling the peak demand load in the respective districts?

H. J. Rohm: In the Pittsburgh district dispatching of electric power and the dispatching of coke oven gas is performed from two different locations. Close coordination of power and fuel operations cannot be obtained under such conditions.

In the Chicago district all electric power and coke oven gas dispatching is performed at the same location.

In the Chicago district the simultaneous 25 and 60-cycle system maximum one-hr demand will approximate 300,000 kw and the contract for purchased power is limited to a 40,000-kw maximum one half-hr "on peak" demand.

In the Pittsburgh district the maximum simultaneous 25 and 60-cycle one-hr demand will approximate 250,000 kw and the purchased power contract has a maximum 15 min "on peak" demand of 60,000 kw.

F. C. McGough: Do I understand by the tertiary cleaning of blast furnace gas you refer to the conventional dust catcher, gas washer, precipitator cleaning sequence?

H. J. Rohm: Yes.

WEIRTON APPLIES HIGH-SPEED SHEET SHEARING TO TINNING LINE

By F. L. REED
Industry Engineering Dept.
Westinghouse Electric Corp.
East Pittsburgh, Pa.

▲ SINCE the speed of the tinning lines is above that at which a flying shear will operate satisfactorily, the Weirton Steel Co. of Weirton, W. Va., a division of National Steel Corp., requires separate shearing lines. New sheet shearing lines to follow a recently installed tinning line have been installed to operate at speeds up to 1200 fpm.

Each of the new lines consists of a coil holder, side trimmer, shear, and classifying section, with one loop between the coil holder and side trimmer and a second loop between the side trimmer and shear. The coil holder will handle coils up to 60,000 lb with diam of 16½ in. inside diam and 85 in. outside diam.

Two adjustable-voltage d-c generators supply power for the drives; one for the shearing section and a second for the classifying section.

The loop between the coil holder and side trimmer is controlled by a photo-thyratron loop regulator. The loop regulator operates directly on the coil holder booster field, while voltage relays measure the booster voltage and reset the coil holder motor-operated rheostat as the booster voltage reaches a specified limit. With this method of control, the loop will remain essentially constant and the motor-operated rheostat in the coil holder field will move in a series of steps from full coil to empty coil.

The loop between the side trimmer and the shear is controlled by a photoelectric regulator working on the shunt field of the side-trimmer motor. This permits the shear to operate at a constant speed regardless of loop position.

The shear is of the rotating drum type and is driven by an adjustable-voltage d-c motor. It will cut sheet lengths from 20 to 46 in.

The classifying section is speed-matched to the shearing section by the use of a regulating pilot generator driven by the shear. This section is arranged to accelerate faster than the shearing section to keep the sheets from overlapping. On deceleration, a timing relay permits this section to run for a period of time after the shearing section stops in order to clear.

A memory-type fault finder indicates both intermittent and permanent operation of protective devices on the line.

By MICHAEL G. SENDZIMIR
Treasurer
Armzen Co.
Waterbury, Conn.
and
LUDWIK ZDANOWICZ
Chief Engineer
Cal-Strip Steel Corp.
Los Angeles, Calif.

a mill for cold rolling metals to close tolerances

▲ THE Sendzimir mill belongs to the rolling mill field, which is confined strictly to the cold rolling of flat products. Early mills were limited to one pair of cylindrical rolls between which a piece of flat metal was passed and reduced in thickness. This type of mill is known as a 2-high mill and its reducing capacity is limited due to the bending effect of the rolls and to the roll flattening effect when the material is reduced to thin gages.

THE 3-HIGH MILL

In order to improve on the 2-high mill, the 3-high mill came into existence. On the 3-high mill, a third roll was introduced between the two rolls of the 2-high mill. In this way, the mill was made more rigid against deflection and yet at the same time, the roll flattening effect lesser. The 3-high mill was particularly well adapted for the rolling of sheets or plates as with a single direction drive, the sheet could be passed either from left to right or from right to left of the mill simply by entering the same either at the bottom or the top of the work roll.

THE 4-HIGH MILL

Further improvement on the 3-high mill was made through the introduction of the 4-high mill with two smaller diameter work rolls. The 4-high mill was not only well adapted for rolling sheets, but also for rolling of strip.

Nevertheless, the fundamental weakness of this type of a rolling mill was its support which acted as a simple beam and deflected under heavy rolling loads unless large diameter rolls were employed.

In the search for smaller diameter work rolls, the cluster-type mill was developed. However, there are certain important differences between the Sendzimir mill and other types of cluster mills.

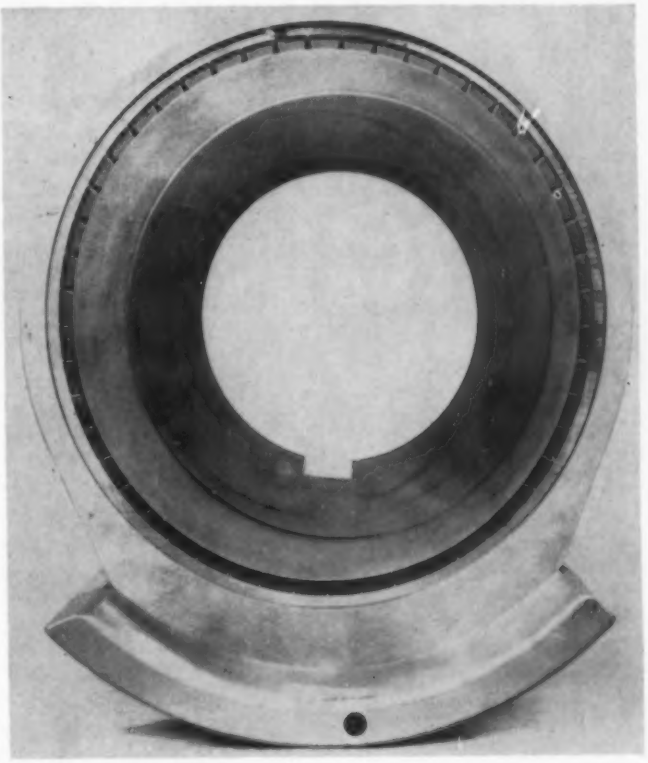


Figure 1 — Backing assemblies are composed of shafts with concentrically mounted roller bearings, located eccentrically in saddle rings.

MILL BACKING

The Sendzimir mill is characterized by one single compact and rigid housing, which holds the backing

. . . . this mill cold rolls strip in both ferrous and non ferrous metals to unusually close tolerances and has been adopted extensively for rolling product where surface finish standards and tolerances are unusually rigid . . . . ability to change rolls quickly helps in attaining this type of product . . . . large reductions may also be obtained in a single pass . . . .

rolls and the work rolls rigidly in place. The backbone and the fundamental idea of this mill is the backing arrangement.

The roll separating force in this type mill passes from the work rolls through the intermediate rolls to the backing assemblies. These assemblies are composed of shafts that have concentrically mounted bearings of the roller type and are located eccentrically in saddle rings which are equally spaced between the bearings. These transmit the work roll separating force directly to the rigid housing across every inch of the width of the mill (Figure 1).

1-2 Mill—The original mill had two work rolls, each of which was supported by two backing shafts which rotated eccentrically in the saddle rings and opened or closed the mill. The first mill had a work roll diameter of 4 in. and a bearing diameter of 9 in. (Figure 2).

It was built in Dusseldorf, Germany as an experimental mill. This mill had a top speed of only 100 fpm and the purpose of its construction was to show that the mill could roll. After the first day's trials an order was immediately entered for an 800-mm wide mill to be located in steel works near Katowitz, Poland.

There were several reasons why the development of the mill occurred at that time. One reason was that the mill promised to produce material of much closer gage accuracy.

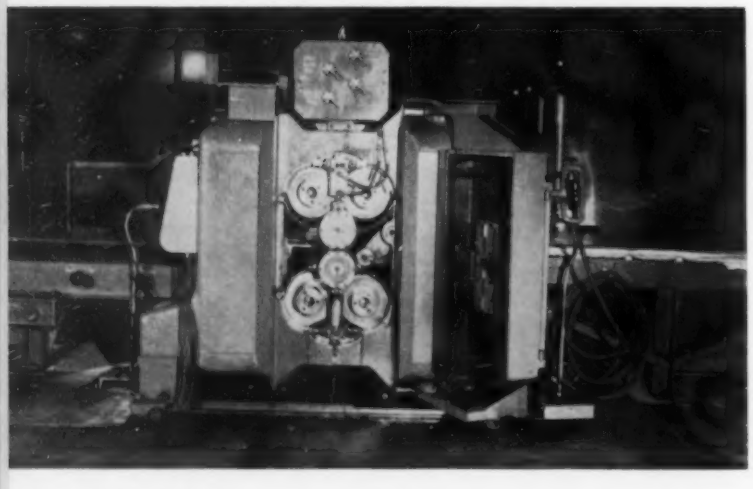
The second mill was built for Fabrique de fer de Maubeuge in Maubeuge, France and was also of a similar arrangement but 40 in. wide.

1-2-4 Mill—On subsequent mills it was necessary to give a heavier backing capacity in order to be able to make heavier reductions on the strip. The possibility of using a smaller diameter work roll was made possible by adding another backing stage. Consequently, the original backing shafts were replaced by solid rolls and each of these rolls was in turn backed by two backup shafts. In this arrangement, the work rolls were driven, one from each side of the mill. Their diameter was around 3 in. The backing bearings were 9 in. in diameter.

This 1-2-4 combination proved to be a long step forward and even today, two 50-in. wide mills of this type are still in commercial operation.

These mills differed a great deal from the mills that are seen today. They were so arranged that the strip ran vertically through the work roll bite and the ends of the strip were welded to each other forming a continuous loop.

Figure 2 — Original mill design had two work rolls each of which was supported by two backing shafts.



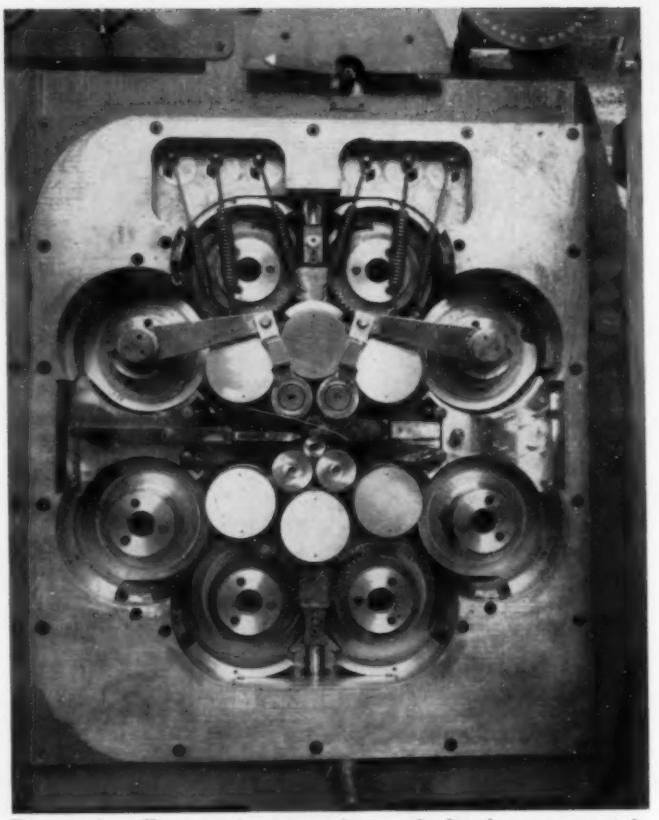


Figure 3 — Two main screwdown shafts have eccentric rings mounted in roller bearings and the others are mounted in plain bearings.

TENSION CONTROL

It was recognized at that time that with the reduction in the work roll diameter, the tension on the strip should be somewhat heavier than for comparable reductions with larger diameter work rolls. Furthermore, this tension had to be much more constant and therefore, it necessitated a new carefully designed tension apparatus.

The original Sendzimir mill, was equipped with this entirely new concept of tension control, heretofore not used.

The apparatus for this tension control consisted chiefly of two large drums on each side of the mill housing to the outside of which were attached smaller rolls in such a fashion as to form a number of little pinch rolls. This system of pinch rolls could apply the necessary front and back tension to the strip.

During the war years, the mill has acquired the modern tension control of a full reversing mill which has constantly been improved and whose uniformity today permits the mill to roll the strip of extremely close gage tolerance in the lengthwise direction.

Postwar Mills—1-2-3—During the war and immediately afterwards, the mill has undergone a considerable change. First came a 1-2-3 arrangement in which the work rolls were supported by two intermediate rolls that were driven, and these two driven rolls were in turn supported by a total of three backing-up shafts on the upper and lower side of the mill. This arrangement permitted the use of tungsten carbide work rolls

and increased the power that the mill could transmit.

In order to get the smallest possible diameter work roll and, at the same time, to give the maximum possible reduction to the strip, a 1-2-3-4 mill was developed.

1-2-3-4 Mill—In the 1-2-3-4 mill, there are eight backing shafts which are numbered "A" through "H" in the clockwise direction, starting at 10:00 o'clock. Shafts "B" and "C" are the main screwdown shafts which are equipped with large hydraulic cylinders on the top of the mill. These shafts have roller bearings *in the saddles* and can be easily rotated under the heavy screwdown pressure. All other shafts have *plain bearings* in the saddle rings and can be rotated only under no-load condition. The other shafts are also self-locking, i.e., in order to open the mill or to close it the shafts have to be positively moved. Shafts "A" and "H" are moved by an electric motor located in the back of the mill and shafts "D" and "E" are moved by a similar motor. These shafts are brought closer together or further apart depending on the size of the rolls in the mill. See Figure 3.

Shafts "F" and "G," the two bottom shafts, are moved by a hydraulic cylinder located in the front of the mill. These shafts are opened or closed in order to change the rolls in the mill. The movement of these shafts serves to bring the work rolls to the pass line of the mill.

Shaft "D" is equipped with a crown control. On the right hand side of the mill are located bolts corresponding to each saddle on shaft "D." When there is no-load in the mill these bolts can be rotated and each individual saddle on shaft "D" can change its height with respect to the housing. In other words, this shaft has double eccentricity. This adjustment enables the operator to give any shape to the mill he desires by adjusting these bolts.

On the 80-in. wide mill, similar adjustment is provided on shafts "B" and "C," acting simultaneously on the two shafts. That adjustment *can be made under load* and, therefore, the operator can change the shape of the strip while the mill is rolling. Some new recent applications of the mill will utilize this principle of crown adjustment as you roll which is motorized through small hydraulic motors and can be controlled by the operator from the operating pulpit (Figure 4).

The driven rolls on the 1-2-3-4 mill are the outer second intermediate rolls. The first intermediate rolls and the work rolls transmit torque but not the torsional moment.

The first intermediate rolls on the mill can be axially adjustable from the front of the mill by two handles which through a mechanical coupling shift the rolls to the front or the back of the mill. This feature is very important for the operation of the mill, since these rolls are ground with a taper and it is possible to control the shape of the edges of the strip to an extremely fine degree.

LUBRICATION

The lubrication of the mill is made by mineral oil for stainless, and non-ferrous metals as well as some low carbon installations. Some of the mills are lubricated by soluble oil. The lubricant enters from the back of the mill through an annulus around the back door

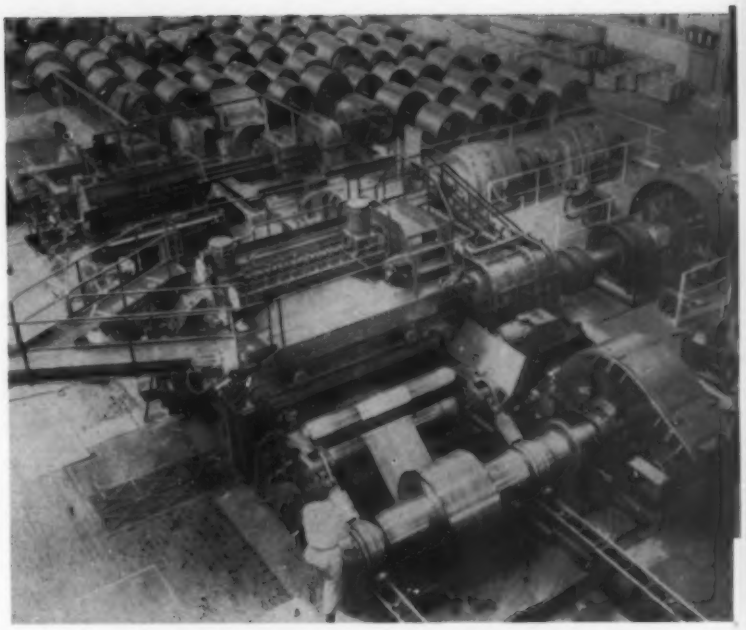
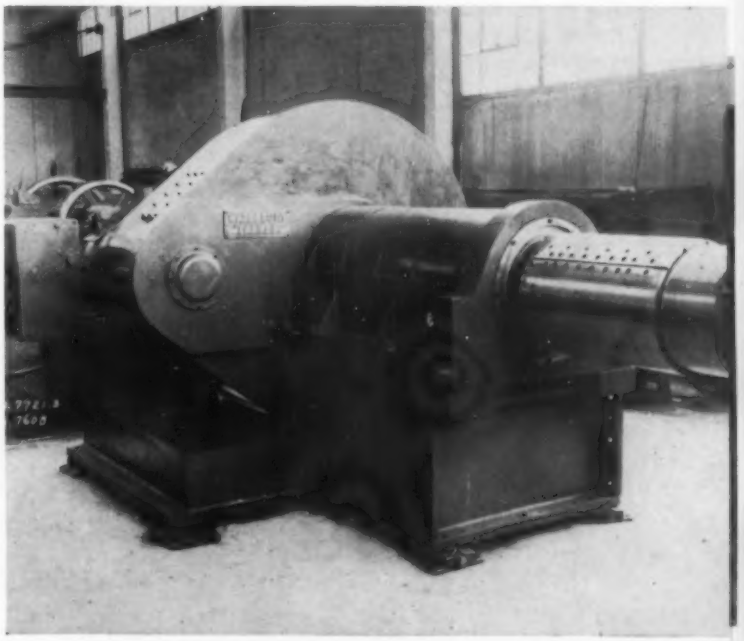


Figure 4 — This mill, located in France, is designed so that the operator can make crown adjustments while rolling. Mill shown is driven by 2500-hp motor and winders are driven by two 800-hp motors.

and then is distributed to the centers of each of the backing shafts that are drilled axially for this purpose. The lubricant passes through these shafts and then flows radially through the bearings, through holes that are drilled in the backing shafts in the radial direction. In this way the bearings are lubricated and cooled. The oil flows next over the rolls and finally onto the strip and extracts some of the heat from it. The oil finally escapes through two pipes located in the front and back of the mill.

Additional oil lubrication is provided to the strip and the work roll bite proper in order to make the reductions of the steel easier. The oil flows through headers located immediately adjacent to the work roll bite where it is sprayed into the roll bite at a high pressure.

Figure 5 — Collapsible winder shown has 20-in. diameter and 27-in. face.



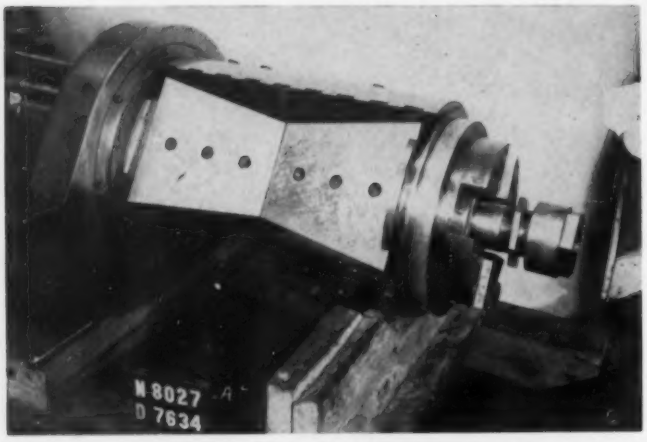


Figure 6 — On the double pyramid winder, an inner shaft actuates the outer pyramid.

Figure 7 — On the quadruple pyramid winder, the shaft collapses the outer elements as it pushes forward. Unit shown has 20-in. diameter and 52-in. face.

The direction of the oil is such that it flows from the center sidewise, and thereby washes away any fragments of the metal that may detach themselves from the strip.

THE COLLAPSIBLE WINDERS

The Sendzimir mill uses heavier tension for reducing the strip and these tensions are especially needed for harder metals, such as stainless steel, titanium and also various alloys. These heavier tensions generate much heavier collapsing pressure on the winder block.

The Sendzimir collapsible winders are made either of a single, double or multiple pyramid. This design differs from the conventional type design as the drum itself is virtually filled with solid metal when it is in expanded position and the strip is being coiled (Figure 5).

On the double pyramid winder, the outer pyramid is actuated by the inner shaft and moves a full stroke to the front of the mill. By means of suitable levers, the covers (Figure 6) which fit these pyramids move one-half of that distance and collapse neatly between the pyramids.

This design is symmetrical when viewed from the front and results in concentrical running of the winder even after considerable use.

On the quadruple pyramid winder, the shaft pushes the outer elements forward and brings them to collapse. The pyramids themselves are attached to the gear and do not move (Figure 7).

DEVELOPMENT OF THE MILL IN THE INDUSTRY

Stainless steels—The biggest prominence that the mill has achieved is that in the stainless steel field. Today the mill has been adopted as a standard tool by nearly every single large stainless steel making plant for rolling of flat products (Figure 7). The ability of the mill to reduce even the hardest austenitic grades of stainless steel from hot rolled gages down to the finished strip has saved numerous intermediate anneals and reduced the cost of processing stainless strip or sheets.

With heavy total percentual reduction without intermediate annealing, the surface becomes more dense and lustrous. One of the biggest factors which puts the mill way ahead of any other mill in this field is the fact that tungsten carbide rolls can be furnished with mirror finish and used for finishing passes. In order to brighten the surface of these rolls they can be sprayed with a diamond powder suspended in oil and lightly polished. This will bring back the highest quality surface finish (Figure 8).

Low carbon steels—The first Sendzimir mills in Europe were used exclusively for rolling of low carbon steel. Today the mill is being accepted for that purpose in this country. The strip, due to superior gage tolerance throughout the coil, is suitable for many important manufacturing processes.

The mill has also found a very important position in rolling very thin gage low carbon strip.

One of the reasons for this is that the strip from the mill is practically flat. On the 80-in. wide mill it was measured to be within 0.0004 in. This feature enables the strip to be slit into a number of narrower strips, each of which would be of the same gage and can be used in a similar fashion.

The second important feature is that of gage variation from one end of the coil to the other. With a small diameter work roll, the variation in the gage during acceleration or deceleration of the mill is smaller than with a large diameter work roll. It can be seen on any such mill that the gage variation during acceleration or deceleration is extremely small and only a fraction of that existing on conventional mills.

A 48-in. wide mill located in Belgium (Figure 9), keeps within 100 per cent of the commercial tolerance of plus or minus 7 per cent.

However, if we now reduce this tolerance to within plus or minus a 4 per cent figure, the mill can keep, on the average, 95 per cent of the material within these tolerance limits.

Figure 8 — The use of tungsten carbide rolls helps produce a mirror finish.

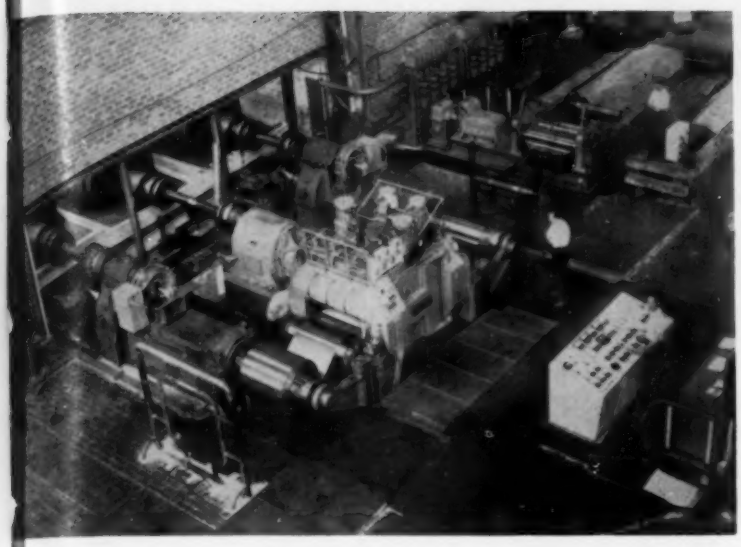


Figure 9 — Excellent tolerances are obtained on this 48-in. wide mill in Liege, Belgium. A 2500-hp motor drives the mill which operates at speeds up to 1500 fpm.

Figure 10 — The mill has found widespread acceptance in the non-ferrous field.

This reversing mill has produced over 22,000 metric tons of low carbon steel per month, 1380 tons during a 24-hr period and one single crew has produced 616 tons during one 8-hr shift. Production is from hot rolled gages to an average gage of 1 mm. In normal rolling practice, reductions of up to 50 per cent per pass are made. This; however, depends on the width and thickness of the hot rolled material.

That mill has a base speed of 750 fpm (speed of full torque of mill motor) and a top speed of 1500 fpm. The mill motor is 2500 hp.

Non-ferrous—The mill has also achieved a prominence in the non-ferrous field. Nearly every brass and copper producer in the USA has such a mill (Figure 10) for rolling of thin gage radiator brass, or for making close tolerance material. Since the work rolls can be changed in only 45 sec (Figure 11), the operator can put a fresh pair of work rolls for the finishing pass and give the material such type of finish as may be desired. At the same time the roughing passes can be taken with used rolls.

Aluminum—The mill is also used to roll aluminum—the soft aluminum as well as one containing magnesium which work-hardens more rapidly and tends to edge crack. Such grades of aluminum as 52S and 56S that contain 3 and 5 per cent of magnesium respectively, are especially difficult to roll. The small diameter work rolls tend to eliminate the stresses in the work roll bite and especially near the edges, and in this way the mill is able to roll the material which otherwise would have to be either annealed or the edges would have to be slit in order to continue rolling. The tungsten carbide rolls are also used on aluminum to give a very shiny and lustrous surface.

Silicon—During the last few years the mill has been used more and more for the rolling of silicon steel especially those of the oriented grain quality. The mill can easily take the first pass reduction on the hot rolled strip of upwards of 40 per cent—even 50 per cent. Furthermore, it can reduce the number of passes that are needed on the standard mills. Any intermediate annealing is needed only for metallurgical reasons. The mill could roll the strip to the finished gages without any intermediate annealing.

One mill rolls 0.013-in. thick strip on the first pass after annealing to 0.003 in., or 77 per cent reduction. On the second pass the mill takes another reduction to 0.002 in.

The gage tolerance, freedom from crown and camber, and the extra high quality finish are especially valuable for silicon steel where the space filling factor is very important. Furthermore, these factors permit the strip from the mill to be easily tracked through the long annealing furnaces. The use of abrasion resistant tungsten carbide rolls on silicon steel is also of a tremendous importance.

Other metals—These mills have also been used for a variety of other metals. Some mills have rolled jewelry material, such as gold and silver. Other mills have rolled bi-metals for jewelry trade as well as for the electrical contacts.

More than one mill is used for rolling of stellite. This

Figure 11 — One feature of the mill is the short time necessary to change rolls enabling a new set to be used on each finishing pass. Work roll length is 84 in.

is an alloy containing a very high percentage of cobalt. This material work-hardens very rapidly and after 50 per cent reduction it reaches a hardness of Rockwell C 55.

One mill has also been used for a number of years for rolling metallic molybdenum. On this metal the reductions are extremely small and a number of passes are needed, but the final gages are only 0.002 or 0.003 in.

Watch spring material has been rolled on these mills. This material after precipitation annealing reaches a hardness of Rockwell C 58. Several mills perform this job and one of them has to hold the tolerance to within plus 2 microns and minus zero.

The mill has also been very successful in reducing commercially pure titanium as well as titanium alloys.

THE FUTURE

Engineers for these mills are constantly working upon improving the design. Higher speeds and higher powered mills are being built every day. Metals that could not be rolled at a given speed and reduction today, can and will be rolled at higher speeds and heavier reductions tomorrow. These advances can be attributed to the improvements in metallurgy of the metal itself, to the improvement in the metallurgy of the rolls, and also, last but not least, to the improved quality of the lubricant and the way in which the lubricant is applied in the mill.

Better roll grinding and better roll grinding techniques will permit brighter and denser surface. Better metallurgy of the rolls will permit less marking of the rolls. Better means for checking the strip surface are also going to be developed in the future.

Gage tolerance will have still a closer check. First of all by means of automatic control of the screwdown; second, through better electrical controls; third, through better roll grinding; fourth, through improvement in gage tolerance of the hot strip, and fifth, through the development of better measuring apparatus.

The development will undoubtedly be towards thinner metals and heavier production at thinner gages. The mill is ripe and ready for that purpose.

Revised and rearranged collection of articles which appeared in the Iron and Steel Engineer between 1943 and 1950 . . . a book for rolling mill men and for anyone interested in rolling mills and roll design . . . written from a practical viewpoint by one who has had considerable experience in the art of roll design.

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CONTROLLED ATMOSPHERES IN HEAT TREATING

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▲ FOR many years the steel and heat treating industries have made use of gaseous atmospheres in their various furnace processes in order to improve the quality and characteristics of steel products. The original furnace atmosphere consisted of the products of combustion which were developed in a direct-fired furnace; it was noted that the air and gas adjustment of the burners greatly affected the surface of the steel being heated.

In many cases sufficient adjustment could be obtained to minimize scale formation to the point where it was not objectionable; as a result, this method of atmosphere control is still being employed on soaking pits, slab heaters, billet heaters and normalizers. In many other cases, it was found desirable to do more than simply minimize scale formation. It was, therefore, necessary to divorce the heating gases from the area surrounding the work and replace them with other atmospheres, specially prepared to accomplish the desired results.

The purpose of this paper is to discuss these prepared atmospheres, the equipment required to generate them, and their applications in the steel industry.

. . . . the development of modern gas chemistry in the laboratories of the steel and heat treating industries has resulted in the creation of standard gaseous atmospheres . . . . various prepared atmospheres for specific processes have been accepted and commercial gas generators are now readily available . . . . this article describes the selection of gaseous atmospheres, their economy and the equipment for their production . . . .

ANNEALING ATMOSPHERES

In the basic steel industry, the largest volumes of prepared atmospheres are required during annealing processes. As a result, a considerable amount of research work has been directed to these atmospheres by the furnace and steel producers and a series of generators have been developed.

Initially, it was observed that a blanket of fuel gas could be employed to surround the steel during annealing and keep it from becoming oxidized. This practice had several drawbacks and was superseded in almost all of its applications as newer atmospheres were developed. It was expensive to use because there was no volume expansion such as obtained in atmosphere generators. As a result, 40 to 60 cent gases were required to seal furnaces instead of 9 to 13 cent gases. In addition, fuel gases contain hydrocarbons which break down and deposit carbon on both the work and furnace which, of course, is not desirable. Also, from a safety standpoint, the use of fuel gas atmospheres was not desirable.

DX Type Atmospheres— The first contribution in the prepared atmosphere generator field was the development of the exothermic gas generator in which a fuel gas is burned with a deficiency of air and the products of combustion cooled by suitable means to provide a reducing annealing atmosphere. This type of atmosphere is known by many trade names and will be referred to in this paper as "DX gas." It is the most widely used of any of the conventional atmospheres and is being employed today in some capacity in all steel mills for the annealing of sheets, strip, rods, tubing and other products. Although other atmospheres have been evolved for some applications, DX gas is such a useful tool to the steel industry that DX gas equipment is still being developed and improved.

DX gas, as is generally used in the steel industry, consists of the following analysis:

	Per cent
CO_2	5-6
CO	9-10
H_2	10-12
CH_4	0.3
H_2O	0.8 (+40 F dew point)
N_2	Balance

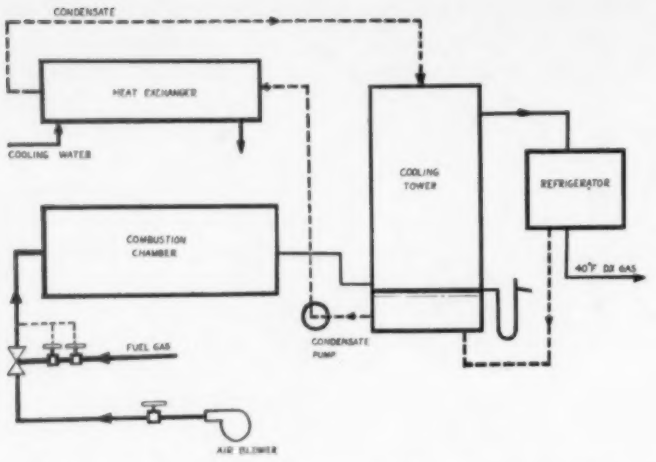


Figure 1 — Generator has a recirculating condensate primary cooler.

DX gas is produced using natural gas or coke oven gas as a fuel, although the other common fuels are suitable. With natural gas, about six parts of air and one part of fuel are mixed and burned in a refractory-lined combustion chamber to insure completeness of combustion to minimize the amounts of residual methane and oxygen. The hot flue products are cooled in a primary cooler to 80 to 100 F and further cooled to +40 F by refrigeration to reduce the water vapor content of the atmosphere and obtain a high hydrogen to water ratio.

At one time or another, considerable time and effort were devoted to the development of either the combustion system and chamber or to the refrigeration system, but of late the primary cooler has received considerable attention. Early DX units employed either spray or packed towers as primary coolers, the gas being cooled by direct contact with cooling water. It was found that the DX gas produced from such units contained excessive oxygen and would discolor steel, if the gas was not pretreated.

To overcome this problem, the indirect cooled DX generator was developed. Here, the hot flue gas is passed through a shell and tube type heat exchanger and cooled indirectly so that the cooling water does not come in contact with the DX gas. This technique permits the production of quality DX gas containing less than 20 ppm of oxygen. The great majority of the generators in current use are of this type.

However, indirect cooling imposes several problems: (1) carbon deposition in the cooler tubes or tube bundle caused by the relatively slow cooling of the carbonaceous gas as compared to quenching the gas in a tower, (2) difficult cooler maintenance due to the fact that both the water and gas sides of the cooler are subject to fouling, and (3) short heat exchanger life caused by the severe conditions of temperature under which the exchanger must operate.

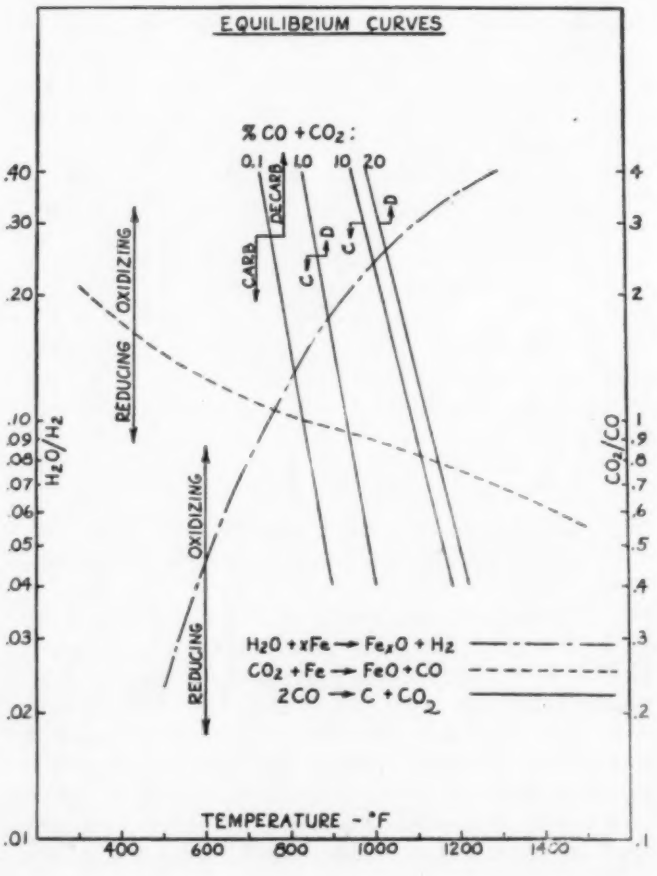
In order to overcome the disadvantages of both cooling systems and to utilize their individual advantages, the patented recirculating condensate cooling system shown in Figure 1 was developed. In this system, the flue gas is rapidly cooled by direct contact with the cooling medium in a tower. The condensate resulting from the cooling of the gas is then pumped through an indirect cooler, and recirculated back into the top of the cooling tower. With this system, quality DX gas is produced since cooling water does not come in contact with the gas. Cooler maintenance is minimized since the cooler handles 100 to 150 F liquids and not 2000 F gases, and cooler fouling is confined to the water sides only. A considerable number of DX generators of this type are in operation, and the majority of the new installations will be of the recirculating condensate type.

DX gas has several attributes which will keep it in use in those many cases which do not require that the surface of the annealed material be of super-quality. First, it is the lowest cost of the prepared atmospheres, about 9 cents per 1000 standard cu ft, based on fuel gas at 40¢/MMBtu, electricity at 1¢/Kwhr, cooling water at 6¢/M gal; secondly, the equipment required to produce DX gas is simple and inexpensive in comparison to that for the special hydrogen-nitrogen atmospheres to be discussed. Third, it is a very highly reducible gas and will deoxidize lightly oxidized steel surfaces during normal annealing cycles.

A glance at the equilibrium curves of Figure 2 shows why DX gas is not universally suitable.

The oxidation-reduction curves show that the carbon monoxide and carbon dioxide composition of DX gas is reducing to iron oxide over the entire annealing range of heating and cooling. However, the hydrogen and water composition becomes oxidizing to iron below 650 to 700 F and experience indicates that the oxidation reaction predominates. As far as carbon monoxide decomposition is concerned, Figure 2 indi-

Figure 2 — Equilibrium curves are given for normal annealing temperature range.



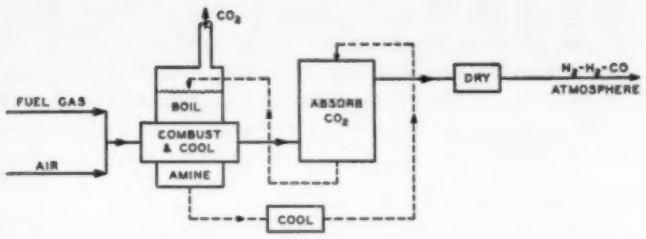


Figure 3 — Schematic shows preparation of N_2-H_2-CO atmosphere from fuel gas and air.

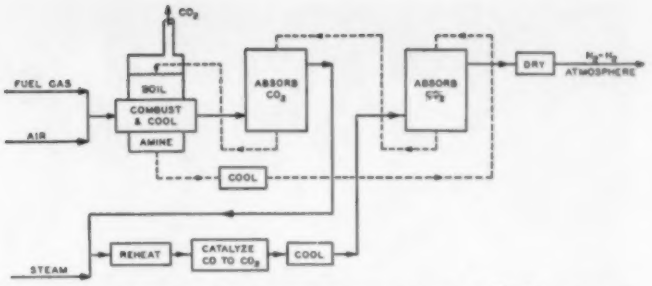


Figure 4 — Schematic shows preparation of N_2-H_2 atmosphere from fuel gas and air.

cates that below 1150 F DX gas tends to deposit carbon.

Equilibrium curves show the direction of the reactions. The actual amount of oxidation and carbon deposition which will occur is dependent upon the length of time the steel remains in these critical temperature ranges while in contact with the DX atmosphere. Short cooling cycles minimize the problem and long cooling cycles accentuate it. Extremely long cycles as are encountered during batch annealing of large coils of tin plate stock result in considerable oxidation and carbon deposition. As a result, the metal surface is not clean and considerable difficulty is encountered during electrolytic tinning operations. In order to rectify this condition, the high nitrogen atmospheres were developed and put into use for operations where superior surface characteristics are necessary.

NX Gas—The first dry nitrogen gas developed contained some carbon monoxide and hydrogen and will be referred to as NX gas. Essentially it is DX gas from which the water vapor and carbon dioxide have been removed. A typical NX analysis is as follows:

	Per cent
CO_2	0.0
CO	1-5
H_2	1-5
CH_4	Trace
H_2O	0.013 (—40 F dew point or less)
N_2	Balance

The carbon monoxide content of NX gas is kept low to minimize carbon deposition. The CO_2 and water vapor contents are low to avoid oxidation.

NX gas is prepared as shown diagrammatically in Figure 3. Natural gas is the most commonly used fuel although coke oven gas and propane are successfully employed. Air and natural gas are proportioned in a ratio of 8 or 9 to 1, mixed and burned to completion in a refractory-lined chamber. The products of combustion are then passed through an absorption system where the carbon dioxide is removed from the gas by reaction with a water solution of an organic chemical called monoethanolamine or MEA. The gas leaving the absorber is then dehydrated (by refrigeration to 40 F and subsequent adsorption on activated alumina) so that essentially the process gas is free of CO_2 and water vapor.

The MEA solution circulates in a closed system comprised of a boiler (wherein the solution is boiled to release its absorbed CO_2) heat exchangers for cooling the regenerated solution to an efficient absorbing temperature, and an absorption tower in which the cooled solution is used to scrub the process gas free of CO_2. As is indicated in Figure 3, the combustion chamber is enclosed within the boiler and the heat of combustion provides the heat necessary for MEA regeneration.

The equipment required to produce NX gas is necessarily more complex and expensive than that for DX gas; however, the same utilities are required—namely, fuel, cooling water, and electrical power. The cost of NX gas is about 10¢ per thousand standard cu ft which is slightly more than an atmosphere of DX gas.

NX gas was developed because of several advantages over DX gas. At conventional annealing temperatures, NX gas is deoxidizing to steel and has only a slight tendency to deposit carbon in the 800 to 900 F temperature range. It is more stable than DX gas since little CO_2 and water vapor are present, and there is little change in the furnace atmosphere when the following reaction occurs:

$$CO_2 + H_2 \rightleftarrows CO + H_2O$$

For this reason, low dew points can be maintained in a furnace using NX gas. With DX gas the reaction of the constituents comprising the gas cause the furnace dew point to be considerably higher than that of the prepared gas. NX gas also has the advantage of being less hazardous than DX gas. As it is normally used, NX gas contains less than 4 per cent combustibles and is nonexplosive, thus making it an excellent purge gas.

In the annealing of tin plate stock for electrolytic tinning lines, NX gas proved superior to DX gas primarily because of its lower percentages of oxygen and carbon bearing constituents. NX gas itself has succumbed to progress for this application and is being replaced by another atmosphere.

Like DX gas, NX gas still has many applications to the steel industry. It is conveniently stored and used as an inexpensive, dry, nonexplosive purge gas and diluent in continuous strip furnaces which employ high hydrogen process atmospheres. It also finds use as safety purge gas in batch and continuous furnaces in the specialty steel field. It is neutral to carbon in steel over a wide range and is used to prevent decarburization of medium and high carbon rod and bar stock and low alloy sheets. To some extent, NX gas is also employed as a carrier in carbon restoration work, being enriched with a suitable carburizing gas.

HNX Gas—Since the quality of electrolytic tinplate was improved by the transition of annealing atmospheres from DX to NX, it was reasoned that the removal of all oxygen and carbon bearing gases would result in further improvement. For this reason, the dry hydrogen-nitrogen or HNX atmosphere (patent

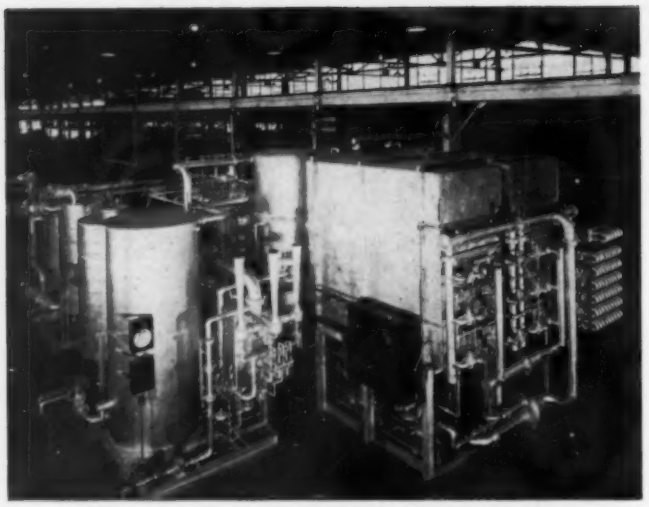


Figure 5 — Gas generator shown is rated 25,000 cfhr.

pending) was developed. In the initial development of this atmosphere, the process and equipment required to produce hydrogen and nitrogen mixtures from fuel gas and air was first perfected in the laboratory. The equipment was then shipped to a steel mill where full-scale batch annealing tests were conducted. These tests showed that tinplate stock annealed in HNX gas was cleaner, brighter and possessed superior surface qualities to that annealed under the same conditions in NX gas.

The wetability of the steel base stock was markedly improved resulting in greatly improved corrosion resistance of electrolytic tinplate. As a result, almost all batch annealing of electrolytic tinplate stock is already being done, or will be done in an HNX type atmosphere. It should be mentioned, however, that HNX gas is not the magic cure-all. It only permits the attainment of superior results, providing the many other conditions which also affect the ultimate product are correct. For example, the steel must be clean prior to annealing, annealing temperature must be adequate, the steel analysis must be correct, etc.

HNX gas, as it is generally used in the steel industry, is composed essentially of the following:

	Per cent
CO_2	0.0
CO	0.0
H_2	2-8
CH_4	Trace
H_2O	0.013 (less than —40 F dew point)
N_2	Balance

Figure 4 shows diagrammatically how HNX gas is produced from fuel gas and air. Essentially the process is a modification of the NX generator with its MEA and dehydrating systems to which a component for the removal of carbon monoxide has been added.

In greater detail, the flue gas from the refractory-lined combustion chamber is cooled and passed through one absorber tower wherein the bulk of its carbon dioxide is removed. Steam is added to the partially purified process gas, the mixture heated, and passed over a bed of catalyst where the following reaction occurs:

$$CO + H_2O \rightleftarrows CO_2 + H_2$$

By adding an excess of steam, keeping the CO_2 content of the process gas low, and operating at a relatively low temperature, the reversible reaction is made to go in the proper direction. The carbon monoxide is thus effectively removed from the process gas by conversion to CO_2. The CO_2 is then absorbed in the second

Figure 6 — Schematic shows preparation of N_2-H_2 atmosphere from ammonia and air.

absorber tower and the gas dried by refrigeration and absorption.

The equipment required to produce HNX gas is slightly more complex than that for NX gas because of the carbon monoxide conversion step. HNX gas costs slightly more to produce than NX gas because of the addition of steam to the process. The cost of HNX is about 13¢ per 1000 standard cu ft.

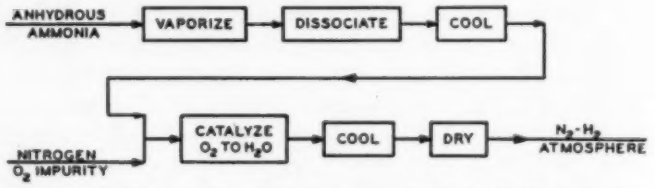
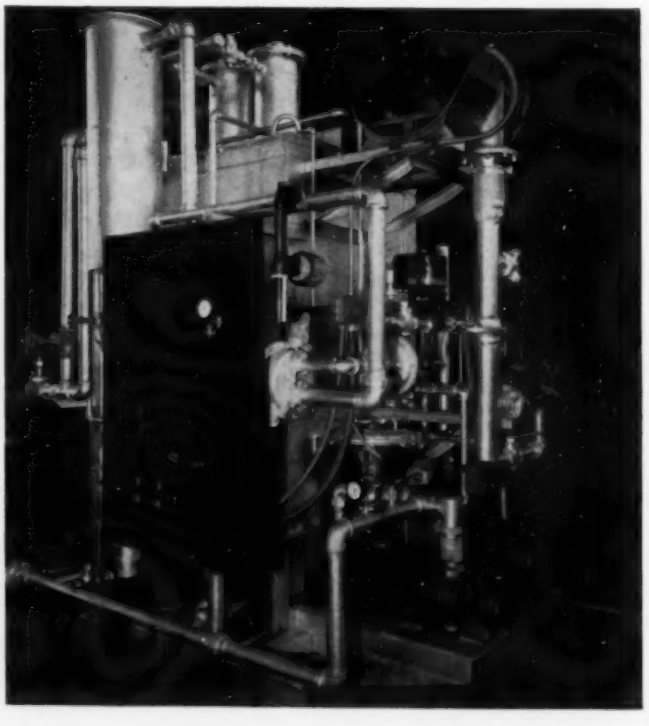


Figure 7 — Schematic shows preparation of N_2-H_2 atmosphere from nitrogen and dissociated ammonia.

HNX gas is similar to NX gas because it too makes an excellent purge gas when its hydrogen content is maintained below 4 per cent. HNX gas is deoxidizing to steel and has a tendency to be slightly decarburizing in batch type annealing processes. Since virtually all of its oxygen and carbon bearing constituents have been removed, it cannot oxidize steel nor deposit carbon.

Besides being widely used in the batch annealing of

Figure 8 — RX gas is widely used in many heat treat processes.



tinplate stock, HNX gas is also being used in continuous strip annealing furnaces for tinplate. It is preferable to NX gas in the cooling zones of continuous galvanizing furnaces and has found use in this capacity. Wherever superior surface qualities are required, HNX gas tends to provide the answer as an inexpensive hydrogen-nitrogen atmosphere.

The value of dry hydrogen-nitrogen atmospheres to both ferrous and non-ferrous industries is apparent, and means for producing this gas from several sources have been developed.

The most widely used process utilizes fuel gas and air in the HNX system described. Generally speaking, this is the cheapest way for producing the atmosphere.

A second source is the catalytic reaction of anhydrous ammonia with air followed by suitable drying. Very pure gas can be produced by this method at a relatively high cost of 70 to 80¢ per 1000 cu ft. For small units, this equipment cost is less than that for the HNX system. For large units, ammonia storage is an appreciable cost. Figure 6 shows the flow sheet for this process.

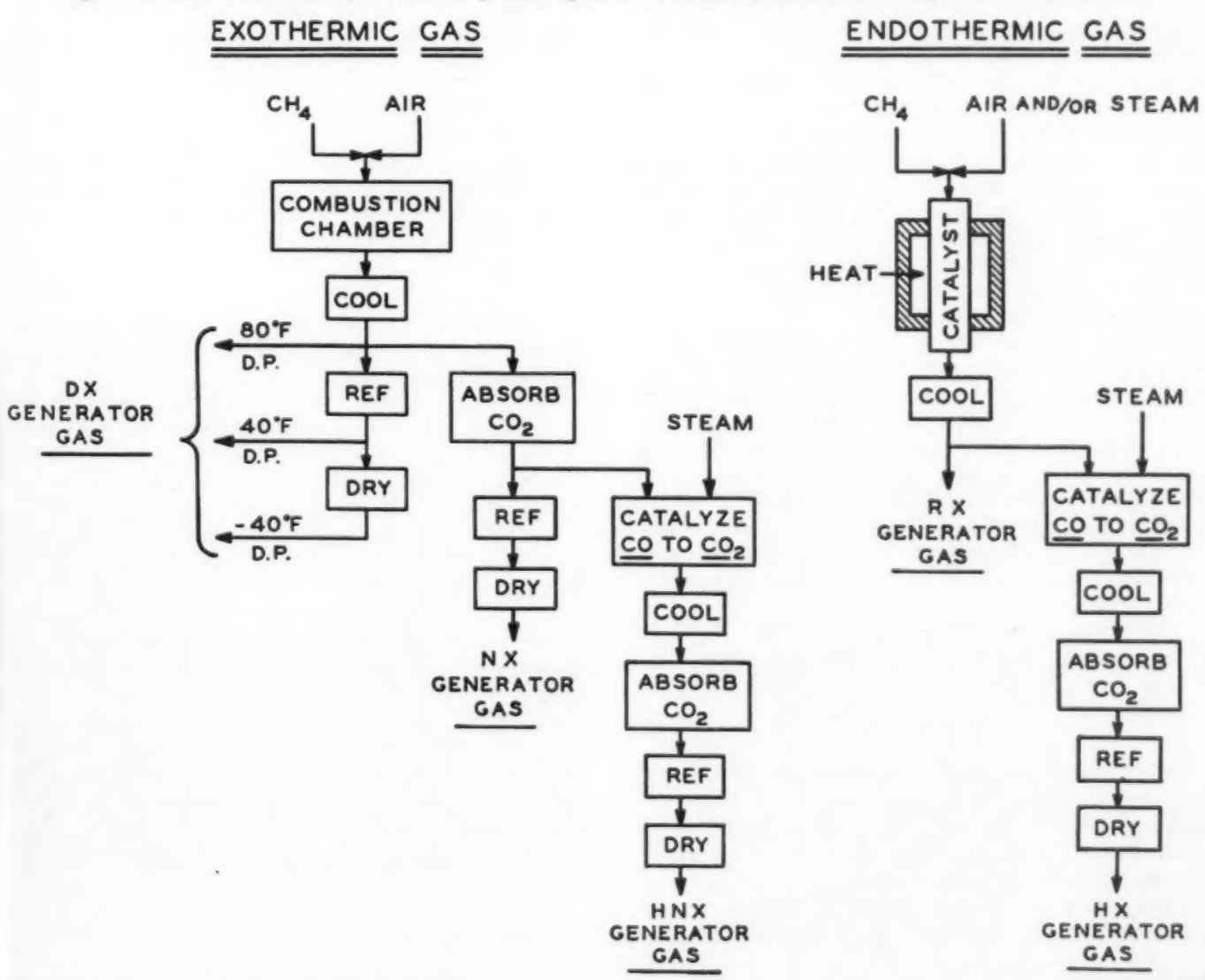
By-product nitrogen can provide an economical source of H_2-N_2 gas (hydrogen-nitrogen mixture) with low equipment cost, providing the source of nitrogen is available. With this method anhydrous ammonia is cracked to provide a source of hydrogen which is blended with the by-product nitrogen. The mixture is catalytically reacted to remove residual oxygen from the nitrogen and is subsequently dehydrated. Figure 7 shows the flow sheet for this process. The cost of the gas will depend on the purity of the nitrogen, the minimum cost being about 10¢ per 1000 cu ft for a 5 per cent H_2 gas.

HIGH HYDROGEN ATMOSPHERES

A number of special annealing processes require the use of active amospheres containing high hydrogen contents. Examples would be continuous galvanizing and silicon steel lines, and bright annealing of stainless steels. Where nitrogen is not a problem, anhydrous ammonia is generally dissociated to provide an atmosphere containing 75 per cent hydrogen and 25 per cent nitrogen. In some cases nitrogen is detrimental so a source of nitrogen-free hydrogen is required. This has been generally provided by electrolytic hydrogen or by-product hydrogen, where traces of hydrocarbons are detrimental by electrolytic hydrogen alone.

Needless to say, hydrogen from anhydrous ammonia or electrolytic cells is quite expensive to produce, and

Figure 9 — Flow sheet shows processes for producing controlled atmospheres from fuel gas, air and/or steam.



cylinder hydrogen is expensive to buy. Equipment is available under the name of HX gas to provide a relatively inexpensive source of 50 to 99+ per cent hydrogen from fuel gas and steam or air.

Dissociated Ammonia (AX Gas)—The most commonly used high hydrogen gas is dissociated ammonia which, as the name implies, is produced by cracking anhydrous ammonia. The process and equipment required are simple, the latter consisting of ammonia storage and vaporizing equipment, a heated catalyst retort, and suitable coolers and pressure regulators. Both gas and electric heated dissociaters are obtainable.

The gas produced is low in impurities containing about 30 ppm of residual ammonia and a dew point of −50 to −60 F, the latter depending entirely on the water content of the ammonia. No dehydration equipment is required.

By-Product or Electrolytic Hydrogen— Both by-product and electrolytic hydrogen require some purification before being used in furnace processes. Such purification consists of removing residual oxygen and water vapor. The former is accomplished by passage over a noble metal catalyst wherein oxygen reacts with hydrogen to form water. The water vapor is removed by dehydration.

HX Gas—HX gas is produced by cracking fuel gas with steam or air in an externally heated catalyst retort to form a rich flue gas containing high CO and H_2 content. The flue gas is then treated to remove the carbon-bearing gases leaving hydrogen or hydrogen and nitrogen. Conventional dehydration equipment is used to produce a dry atmosphere.

Essentially the equipment required to produce HX gas is a combination of an endothermic and HNX atmosphere equipment, with the former constituting the primary cracking unit and the latter the secondary reaction, absorption, and dehydration equipment. HX gas costs between 35¢ and 70¢ per 1000 standard cu ft to produce, its costs depending on the hydrogen content required.

RX Gas—The last atmosphere to be discussed is an endothermic atmosphere or RX gas. It consists essentially of 20 per cent CO—40 per cent H_2—40 per cent N_2 and is used widely by the metal treating industry both alone and with other atmospheres. Briefly, RX gas is widely used in many heat treat processes including carburizing, dry cyaniding, carbon restoration and homogeneous carburizing. Innumerable parts are heat treated in RX atmospheres in all types of furnaces from small tool room size to continuous fully automatic lines.

Figure 8 shows an RX generator.

RX gas costs about 23¢ per 1000 standard cu ft to produce.

SUMMARY

The types of prepared atmospheres are many and their fields of application expanding. With the ever-growing demand for new and higher quality steel products, it is expected that the role of prepared atmospheres will continue to increase.

In most cases the main source of today's atmospheres is from the reaction of fuel gas and air so Figure 9 is presented to summarize the various processes for producing the endothermic and exothermic generator equipment discussed.

These are the atmospheres being used at the present time.

As heat treating progress continues, entirely new atmospheres will be required. It can be expected that suitable controlled atmosphere generators will be developed as the need arises.

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County of Allegheny

Before me, a notary public in and for the State and County aforesaid, personally appeared T. J. Ess, who, having been duly sworn according to law, deposes and says that he is the editor of the *Iron and Steel Engineer* and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Acts of March 3, 1933 and July 2, 1946, embodied in section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher: Association of Iron and Steel Engineers, 1010 Empire Building, Pittsburgh, Pennsylvania.

Editor: T. J. Ess, 1010 Empire Building, Pittsburgh, Pennsylvania.

Managing Editor: None.

Business Manager: None.

2. That the owner is: Association of Iron and Steel Engineers, 1010 Empire Building, Pittsburgh, Pennsylvania.

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Sworn to and subscribed before me this 21st day of September, 1956.

ALMA A. JORDAN, Notary Public

(My commission expires January 5, 1959.)

By JOHN ARNOLD, Chief Engineer, Lee Wilson Engineering Co., Inc., Cleveland, Ohio.

A comparison of single and multiple stack annealing furnaces

Single stack annealing operations have a number of advantages which include flexibility, lower installation costs . . . . in addition, an outstanding advantage is the lower product inventory with the single stack plan.

▲ During the last five years a new advance has been made in the annealing of low carbon cold rolled strip. This is the annealing of cold rolled strip in the single stack convection type furnace. More recently, this advanced type of annealing has been selected by a number of the larger steel manufacturers for complete annealing installations. Because of this, the comparison of the single stack furnace with four-stack and eight-stack furnaces has become quite controversial. To bring these controversies to light, and to present the full picture of the advantages of single stack annealing, this paper has been prepared.

To start this study, checks were made with the managing and operating personnel of some of the larger steel producing companies to determine the tonnage rates they would accept for the three types of furnace equipment mentioned above. From the information received at these meetings, this study is based on a mixture of 50 per cent commercial and 50 per cent drawing quality steels, using an 80 per cent loading factor, and for an installation capable of annealing 100,000 tons per month, with production rates as follows:

Single stack furnaces—2 tons per hr
Four-stack furnaces—5 tons per hr
Eight-stack furnaces—8 tons per hr

A layout was made of the floor space necessary for the furnace equipment required for single stack, four-stack and eight-stack designs—Figure 1. Based on these figures, a floor space saving of 30 per cent is shown for the single stack furnaces over a four-stack furnace installation. This drawing points out the number of pedestals that are required on multiple stack furnaces as compared with a single stack furnace installation. In most cases when data on single stack furnace installation is presented, more concern is shown about the number of furnaces needed and the main item is missed, which is the number of base pedestals required in the three different types of furnace installations.

A number of tables are shown to make a statistical comparison of the three types of furnaces under consideration. Table I entitled "Tons per Hour per Furnace" was made up to show the comparable tonnages that may be obtained from the single stack, four-stack and eight-stack furnaces, when using different percentages of commercial and drawing quality mixtures. It has sometimes been found that in comparing one type of furnace with another, the tonnage rates may indicate low figures on one furnace using a high percentage of drawing quality as compared with another furnace using a high percentage of commercial quality steels. It would be interesting to note from this table that the comparison figures are actually in the middle of the table for the 50 per cent commercial and 50 per cent drawing quality steels, and thus represent a good average condition of operation.

In discussing future furnace installations, it is found that the term "Load Factor" is sometimes misused or mis-interpreted. For this reason, Table II entitled "Load Factors" has been made with the idea that for a series of four-stack furnaces or a series of single stack furnaces taken on a monthly average, and using an average coil weight, the load factor for any given tonnage would be the same. In this particular table for a given load of 240 tons, which is based on an 80 per cent load factor, it would be possible to have a four-stack base loaded as shown on the table, and four single stack bases loaded as shown on the table. However,

TABLE I
Tons per Hour per Furnace at 80 Per Cent Load Factor

	Single stack	4-Stack	8-Stack
100 per cent commercial, 0 per cent drawing	2.25	5.6	9.0
75 per cent commercial, 25 per cent drawing	2.15	5.4	8.6
50 per cent commercial, 50 per cent drawing	2.0	5.0	8.0
40 per cent commercial, 60 per cent drawing	1.8	4.5	7.2
25 per cent commercial, 75 per cent drawing	1.65	4.1	6.6
0 per cent commercial, 100 per cent drawing	1.5	3.75	6.0

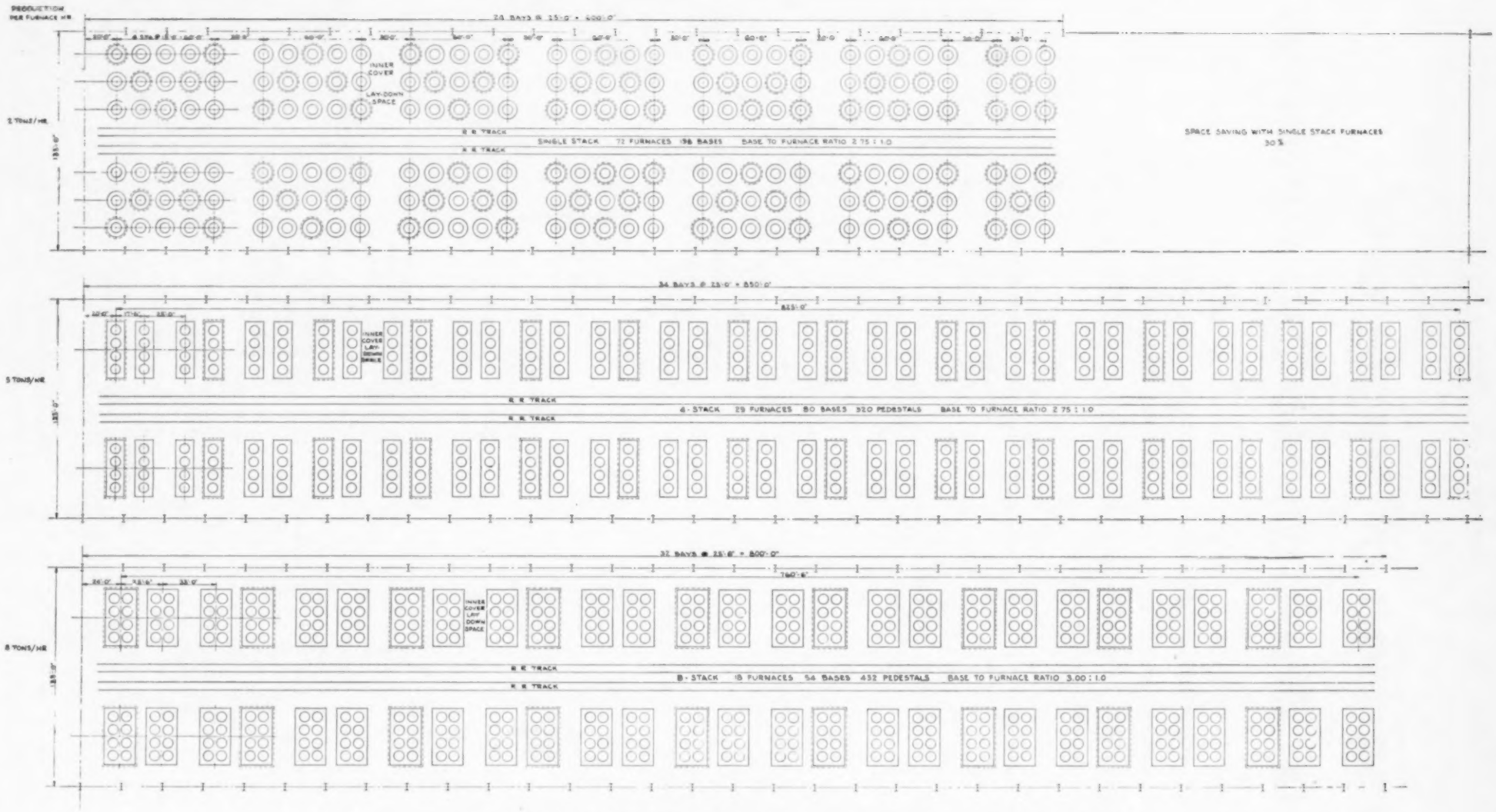
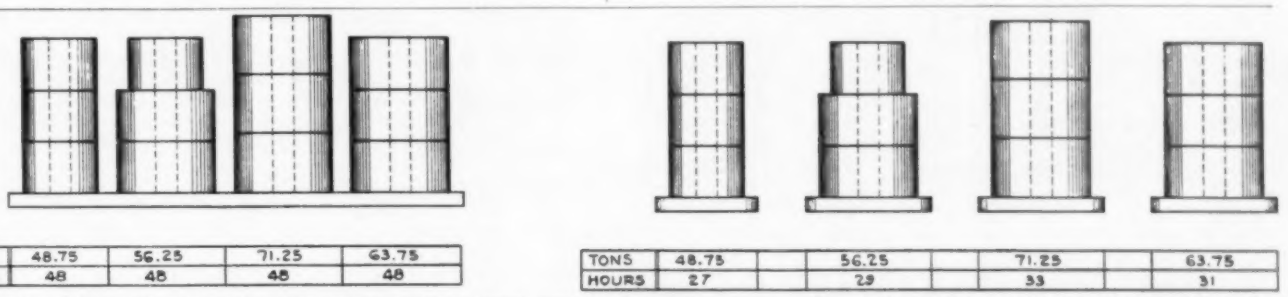

PRODUCTION PER FURNACE HR
24 BAYS @ 25'-0" = 600'-0"
INNER COVER
LAY-DOWN SPACE
2 TONS/HR
R. R. TRACK
R. R. TRACK
SINGLE STACK 72 FURNACES 198 BASES BASE TO FURNACE RATIO 2.75 : 1.0
SPACE SAVING WITH SINGLE STACK FURNACES 30 %
34 BAYS @ 25'-0" = 850'-0"
825'-0"
INNER COVER LAY-DOWN SPACE
5 TONS/HR
R. R. TRACK
R. R. TRACK
4-STACK 29 FURNACES 80 BASES 320 PEDESTALS BASE TO FURNACE RATIO 2.75 : 1.0
32 BAYS @ 25'-0" = 800'-0"
780'-0"
INNER COVER LAY-DOWN SPACE
8 TONS/HR
R. R. TRACK
R. R. TRACK
8-STACK 18 FURNACES 54 BASES 432 PEDESTALS BASE TO FURNACE RATIO 3.00 : 1.0

Figure 1 — Layout shows floor space necessary for single stack, 4-stack, and 8-stack annealing setups capable of handling 100,000 tons per month. Layout is based on 50 per cent commercial and 50 per cent drawing quality steels and calculated on an 80 per cent load factor.

TABLE II

Load Factors

4-Stack furnace			Single stack furnace		
Maximum capacity, tons	Tons per pedestal	Load factor, per cent	Maximum capacity, tons	Tons per pedestal	Load factor, per cent
75	71.25	0.95	75	71.25	0.95
75	63.75	0.85	75	63.75	0.85
75	56.25	0.75	75	56.25	0.75
75	48.75	0.65	75	48.75	0.65
Total	240.00	Avg. 0.80	Total	240.00	Avg. 0.80



TONS	48.75	56.25	71.25	63.75
HOURS	48	48	48	48

TONS	48.75	56.25	71.25	63.75
HOURS	27	29	33	31

Figure 2 — Both the 4-stack and single stack base are loaded the same. Annealing time will be shorter for the single stack units.

load factors will vary with the number of coils that make up the monthly schedule, but for the purposes of this comparison we are showing the load factor for both types of furnace installations as being equal.

Table III is entitled "Production Factors" which is based on the 80 per cent load factor and equal quantities of commercial and drawing quality steels. To determine the number of furnace hours on the four-stack furnace, the total load of 240 tons is divided by the rate of 5 tons per hour to give a heating time of 48 hours. On multiple stack furnaces, the total furnace time would naturally be based on the pedestal with the heaviest charge. On single stack furnaces, the cycle can be set in accordance with the load in each single stack furnace with a total of 120 hours for processing the four single stack charges, to make an average of two tons per furnace hour. Although there is an advantage in cooling on the single stack furnaces, and single stack furnaces are more adaptable to the use of forced coolers, for the sake of simplicity of comparison, all cooling rates for all furnaces have been set at one and one-half times the furnace hours required for each type of charge.

During discussions with operating personnel, the question has always arisen as to the number of crane movements that would be required on single stack furnace equipment. For a clearer picture of this particular problem refer to the table entitled "Crane Movements." This is still based on the 50 per cent commercial and 50 per cent drawing quality mixture with a production of 100,000 tons per month. Assuming the average coil weight of 20 tons, there are 5000 coils to move both into and away from the annealing department (average load 3 coils high for all furnaces). On this basis, for a given production, the number of coil movements, convector plate movements, top cover plate movements and inner cover movements must be identical regardless of the type of furnace. There are more crane movements required for handling the single stack furnaces than for the multiple stack fur-

TABLE III

Production Factors

Tons per pedestal	Heating hours	Cooling hours	Tons per hr heating
4-Stack furnace			
71.25	48	72	1.45
63.75	48	72	1.33
56.25	48	72	1.20
48.75	48	72	1.02
Total 240	192	288	5.00
Tons per hr per furnace	5.0		
Tons per hr per pedestal	1.25		
Single stack furnace			
71.25	33	50	2.15
63.75	31	46.5	2.05
56.25	29	43.5	1.95
48.75	27	40	1.85
Total 240	120	180.0	8.00
Tons per hr per furnace	2.0		
Tons per hr per pedestal	2.0		

Cooling time based on heating time x 1.5

Total heat input to 4-stack furnace: 10,000,000 Btu per hr
2,500,000 Btu per pedestal

Total heat input to single stack furnace: 5,000,000 Btu per hr

TABLE IV

Crane Movements (5000 Coils)

Average coil weight = 20 tons			Single stack	4-Stack	8-Stack
Average load = 3 coils high, tons			60	240	480
Coil movements			10,000	10,000	10,000
Convector plate movements			6,667	6,667	6,667
Top cover plate movements			3,333	3,333	3,333
Furnace movements			1,667	416	208
Inner cover movements			3,333	3,333	3,333
		Totals	25,000	23,750	23,540
*Average available (min) time for crane movement					
3.42	3.63	3.66	2 cranes	2 cranes	2 cranes
5.13	5.45	5.50	3 cranes	3 cranes	3 cranes
6.84	7.26	7.33	4 cranes	4 cranes	4 cranes
(1-stack)	(4-stack)	(8-stack)			
Crane size			30 ton	60 ton	80 ton

* $\frac{\text{43,200 Minutes per month x No. of cranes}}{\text{No. of crane movements}}$

naces, but this is the only difference in movements to be taken into consideration for determining the total number of crane movements required for each type of furnace. There are many incidental movements and interruptions in operation which cannot be evaluated but these are probably identical for any type of furnace.

There are some advantages which accrue to the single stack furnace in handling of inner covers, but in order to eliminate all controversies about such advantages, the number of crane movements has been determined on the actual moves that can be calculated. With totals of 25,000 movements for a single stack installation, 23,750 movements for a four-stack installation and 23,540 movements for an eight-stack installation, Table IV shows average time per crane movement for two, three and four cranes. This is determined by dividing the total number of crane movements into the total time available of 43,200 minutes per month per crane. The resulting figures indicate that there was so little difference between the average time available for crane movements for all three types of furnaces that there is no logical basis of ruling against single stack furnaces because of the number of crane movements required.

In a department of the size indicated, a minimum of three cranes would be required, but for the single stack furnaces a considerably lighter crane could be used as the crane could be selected according to maximum coil size and not for furnace weight. In a new installation this would make a considerable saving in the cost of the cranes and in the cost of the annealing building.

Table V shows the number of thermocouple readings per month, which is a direct labor requirement. In some of the discussions on single stack equipment, the thought has prevailed that there would be more labor required on the operation of the instrumentation on the single stack furnace equipment than on the multiple stack equipment. This table shows the number of furnaces, pedestals and thermocouples that are required for the three different types of installations. The total number of readings, as indicated, is considerably more for the four-stack and the eight-stack furnaces than for the single stack equipment. It also indicates that any instrument charts that would be kept by the operating personnel on a single stack furnace would be the data on a single charge. When back-checking on multiple stack furnaces, there would possibly be four or eight sets of temperature readings on one furnace instrument chart which would require more time to interpret the data properly.

TABLE V

Number of Thermocouple Readings per Month
Heating and Cooling
For 100,000 Tons per Month

	Single stack	4-Stack	8-Stack
Furnaces	72	29	18
Pedestals	198	320	432
Number of thermocouples	270	349	450
Number of hours	700	700	700
Total readings	700 x 270 = 189,000	700 x 349 = 244,000	700 x 450 = 315,000
Per cent increase in number of readings	...	29	67

TABLE VI

Maintenance Items
For 100,000 Tons per Month

	Single stack 72 furnaces 198 pedestals	4-Stack 29 furnaces 320 pedestals	8-Stack 18 furnaces 432 pedestals
Base fan motors	198 (15 hp)	320 (15 hp)	432 (15 hp)
Base fans	198	320	432
Heater tubes	720	725	900
Burners	720	725	900
Thermocouples (base)	198	320	432
Furnace blower motors	72 (5 hp)	29 (10 hp)	18 (20 hp)
Instruments	72	58	36
Inner covers	198	320	432
Gas pressure regulators	72	29	18
Thermocouples (furnace)	72	58	36
Bases (pedestals)	198	320	432
Total maintenance items	2,718	3,224	4,068
Per cent increase	...	18.6	49.0

TABLE VII

Fuel and Power
For 100,000 Tons per Month

Power	Single stack	4-Stack	8-Stack
Total connected load, hp	3,330	5,090	6,840
Per cent increase	...	33	80
Base fan motors	198 (15 hp)	320 (15 hp)	432 (15 hp)
Average load per cycle, amp.	8	5.5	4.1
Average kw per hour	5.45	3.75	2.8
Kwhr per month	809,870	840,000	846,720
Blower motors	72 (5 hp)	29 (10 hp)	18 (20 hp)
*Average load per cycle, hp	2.5	4.75	8.5
Average kw per hr	1.66	3.24	5.8
Kwhr per month	83,664	65,500	73,080
Total kwhr per month for base fans and blowers	893,534	905,500	919,800
Per cent increase	...	1	3
Fuel			
Average Btu per ton	875,000	900,000	950,000
Cu ft of natural gas per ton	875	900	950
Per cent increase	...	3	8
Atmosphere gas			
Cfhr per pedestal	350	350	350
Number of pedestals	198	320	432
Total cfhr @ 700 hr	69,300	105,000	150,600
Per cent increase	...	50	115

*Average load per cycle based on fuel input of 50 per cent of total input available through charge for single stack, 35 per cent for 4-stack and 25 per cent for 8-stack.

Pursuing the question of additional labor requirements within the annealing department, Table VI shows the maintenance items required for the three different types of furnace installations. Some of the items listed are inherently greater for any one type of installation over another. For instance, more base fan motors, fan impellers, heater tubes, burners, thermocouples, inner covers and base pedestals are required on the four-stack and the eight-stack furnaces than are required on the single stack installations. More blowers, blower motors, instruments and gas pressure regulators are required on the single stack furnaces as compared with the four-stack and eight-stack furnaces. However, in total number of principal maintenance items, there is an increase of slightly more than 18 per cent for the four-stack furnace over the single stack, and 49 per cent for the eight-stack furnace over the single stack. The one item that, while larger in number, has a distinct advantage for the single stack equipment is the number of instruments required—72 for the single stack furnace, 58 for the four-stack and only 36 for the eight-stack furnaces. Each single stack furnace has its own complete control for each stack of coils. With the demand in the industry for better steels no better way could be devised for the quality and uniformity of each charge.

TABLE VIII

Process Inventory on Pedestals Only
For 100,000 Tons per Month

	Single stack	4-Stack	8-Stack
Furnaces	72	29	18
Pedestals	198	320	432
Tons @ 60 ton average	11,880	19,200	25,920
Dollar value @ $100.00	$1,188,000	$1,920,000	$2,592,000
Dollar value difference	...	$ 732,000	$1,404,000

TABLE IX

Total Investment

	Single stack	4-Stack	8-Stack
Process inventory	$1,188,000	$1,920,000	$2,592,000
Furnaces			
Buildings			
Foundations			
Installation			
Cranes (3)			
Totals	$7,645,000	$11,477,000	$13,672,000
Per cent increase	...	50	80

Table VII is entitled "Fuel and Power Requirements." The total connected load, including the base fan motors and the furnace air blower motors, totals 3330 hp on the single stack furnaces, 5090 hp on the four-stack furnaces and 6840 hp on the eight-stack furnaces. This is an increase of 33 per cent on the four-stack over the single stack and 80 per cent on the eight-stack over the single stack. On the 15 hp base fan motors, the average power load per cycle is shown and also the total kwhr per month. It is interesting to note that from actual test data taken on operating furnace installations, that the single stack furnaces show a higher average hourly load on the individual base fan motors than do the four-stack or the eight-stack furnace equipment. The reason for this power increase is the higher volume of gas that is recirculated in a complete convection system. This requirement is essential in a true convection heating unit and accounts for the higher production per hour per pedestal unit.

This complete convection system also utilizes the higher input per furnace unit of 5,000,000 Btu per hr that is available on single stack convection type furnaces. With these requirements per pedestal, it is interesting to note that no greater over-all power is required per month than for the four-stack or the eight-stack furnaces. Basing fuel consumption on the use of

natural gas, a slight saving is shown over an acceptable figure on fuel economy on the four-stack or the eight-stack furnaces. On the question of atmosphere gas requirements, a figure for a 72 x 156-in. high furnace of 350 cfhr per stand was used. This is acceptable in most installations. However, if it is determined that the requirements are only 300 cfhr, this figure would be identical in all three types of installations. Because of the difference in total number of pedestals, the atmosphere gas requirements are considerably higher for the four-stack and the eight-stack furnaces as compared with the single stack installations.

Probably the most important table of comparison of all in so far as company management is concerned is that of "Process Inventory" (Table VIII) in the annealing department. This table shows the actual comparison of the number of tons of steel that are on the annealing pedestals for a production of 100,000 tons per month and startlingly shows what a tremendous dollar value investment is tied up on the multiple stack bases as compared with the single stack bases. The dollar value per ton at this stage of annealing is probably over one hundred dollars, but that figure is used in the table, and adjustments can be made for the price increases that have occurred since this study was made. When almost three quarters of a million dollars worth of steel is tied up on a four-stack base installation more than on a single stack installation, and with a figure at twice this level for eight-stacks, it must be realized that this amount of money is just as much of an investment in the annealing department as the furnaces, foundations, and building, and this figure must be included in the total investment cost that has to be considered when a selection of equipment is made.

A table on "Total Investment Cost" follows (Table IX) in which only the individual cost of process inventory is listed, but the total investment costs of single stack and multiple stack installations are shown, based on actual investments for each type of equipment. Operators agree that three cranes are necessary for an installation of this size, but of course there is a difference in the crane cost and building cost for each type of installation. Foundations for the single stack equipment are very much simplified as compared with the large pits that are used for the multiple stack furnaces, and the installation costs are lower because there are so many fewer pedestals to pipe and to which wiring connections must be made.

With all of the other advantages of the single stack equipment so marked, the large differential in total investment would be a final reason to select single stack furnaces.

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integrated electro-mechanical press puller drive system IMPROVES EXTRUSION QUALITY

. . . . the puller drive system is an important factor in successfully producing economical extrusions . . . . all performance expectations have been met by the unit . . . .

By R. C. SUTTLE

Application Engineer, Metals Division, Reliance Electric and Engineering Co., Cleveland, Ohio

▲ AT the new Dow Chemical plant in Madison, Illinois, magnesium extrusions are now successfully produced in a variety of shapes, without intermediate straightening, through the aid of press "puller drives" —the end result of a series of evolutionary steps. The integrated electro-mechanical drive system has brought about a marked improvement in extrusion quality while eliminating the need for intermediate straightening of the extrusions.

One of the primary limiting factors in metal extrusion has been the need for intermediate straightening of the extruded metal before final straightening. Intermediate straightening has been an absolute requirement because of localized chilling of the extrusion die which caused the metal to be extruded in irregular curled shapes as parts of the die changed temperature relative to the other parts. Heaters are often installed in the die, but do not completely compensate for localized chilling. Up to very recently, most extrusions were carried away from the die only by the extruding process itself or manually. After envisioning an automatic process without intermediate straightening, several versions of tuggers were tried, but the indeterminate characteristics of hydraulic presses made it difficult to accomplish the desired results by conventional control means.

Steps were taken at Dow to improve the operation by the application of fully regulated, automatic drives. Wide tension range requirements and variations in extrusion rate required the consideration of what are known as puller drives. This fully automatic puller drive which was developed reduced manpower requirements with all of the steps now accomplished automatically and controlled by a single pushbutton at the central operating point.

The puller drive system has been highly successful in accomplishing the original requisites, and most advantageous in terms of installation ease and maintenance facility. Accurate puller tension is provided through the use of an air-loaded tensiometer, thereby divorcing the normal mechanical and electrical variations. Of great importance is the fast action of the electrical equipment which is afforded by electronic regulators to enable high speed response to meet the indeterminate characteristics of the hydraulic presses. The automated cycle is integrated with the press and subsequent handling equipment to give fully automatic operation. Ease of installation and maintenance are provided by the utilization of "packaged" adjustable-speed control units.

INTRODUCTION

During the final stages of World War II and during the Korean emergency, the heavy press program necessitated the development of a number of material handling techniques which were not previously known. One such development was an extrusion press puller and its associated electrical drive at the Dow Chemical Co.'s Madison, Illinois, plant.

This press puller has three distinct functions:

1. To provide a flexible material handling device which will allow minimum idle press time and full automatic control.
2. To provide a controlled tension range that will afford extrusions that do not require straightening.
3. To provide a flexible drive that will, by simple adjustment, operate over a wide variation of products and speed range.

GENERAL ARRANGEMENT

The puller setup consists basically of an overhead bridge with rails for the support and transportation of the pull head, puller cable, pull head, cable drum, re-

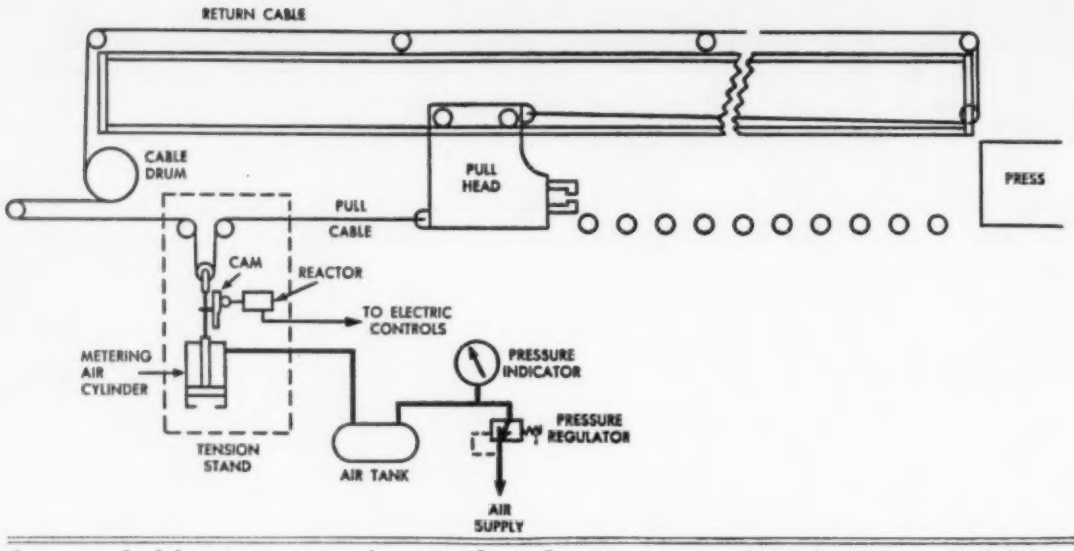


Figure 1 — General arrangement of puller.

ducer and drive motor, tension stand, and return cables, Figures 1 and 2.

The overhead bridge must support only the weight of the pull head; the main pulling action is maintained between the cable drum, tension stand, and the pull head. On the press illustrated, an overhead arrangement was used for easy access to the cooling bed and subsequent handling conveyors, Figure 3. On larger presses, the rails can be grouted into the floor with the pull head then taking the form of a carriage or car.

The pull head, Figure 4, is a light weight, strong structure having the minimum possible inertia, while maintaining adequate rigidity for the requirements of maximum tension. The pull head contains its own hydraulic power pack for operation of the gripping jaws. Dogs are provided in the front and rear of the pull head for positive engagement of positioning limit switches. Electric service and control circuitry to the pull head can be provided either by trolley duct, or by cable as used on the puller being discussed.

The cable drum is 30 in. in diam and provides three sections of grooves, two return cables (to be unwound as the pull cable is wound up), and the single main pull cable section. Sufficient guide sheaves are used so that the proper fleet angle can be maintained within the limits of recommended practice as outlined by cable manufacturers. The cable drum is overhung on the output shaft of a two-stage reducer.

The drive motor provided was a heavy-duty unit with the following specifications: 15 hp, 575/2300 rpm, 230 volt, drip-proof protected, enclosed, blower-ventilated, shunt-wound, d-c, continuous duty, 40 C rise.

This motor was designed with high overload capacity and with low inertia for dynamic response.

The tension stand, Figure 5, consists of two fixed guide sheaves, one movable sheave supported by a guided yoke attached to the shaft of a metering air cylinder, a cam assembly operating a short stroke reactor, and the pneumatic regulator system. Shop air is used for the system source.

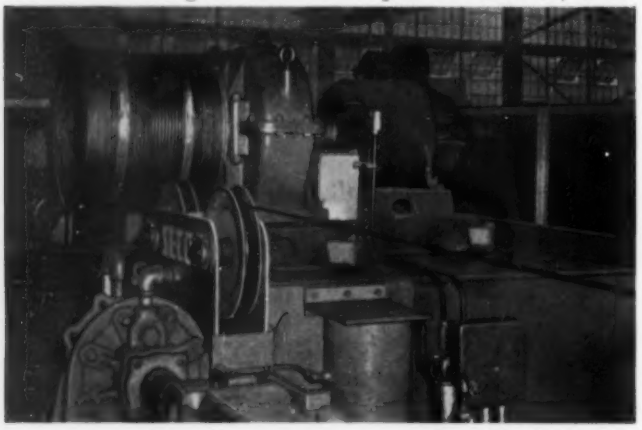


Figure 2 — View shows cable drum, reducer, drive motor and tension stand.

Figure 3 — An overhead arrangement is used for access to the cooling beds.

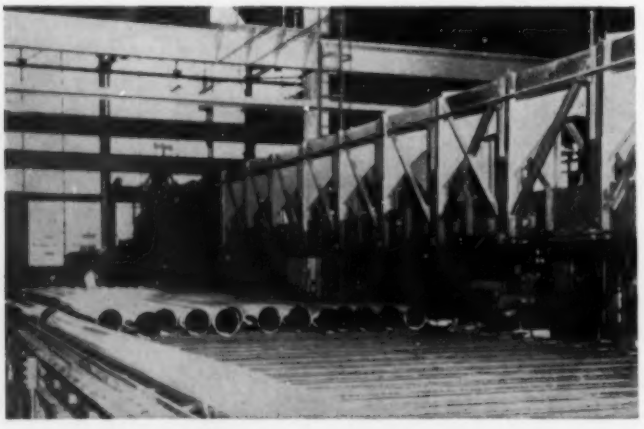
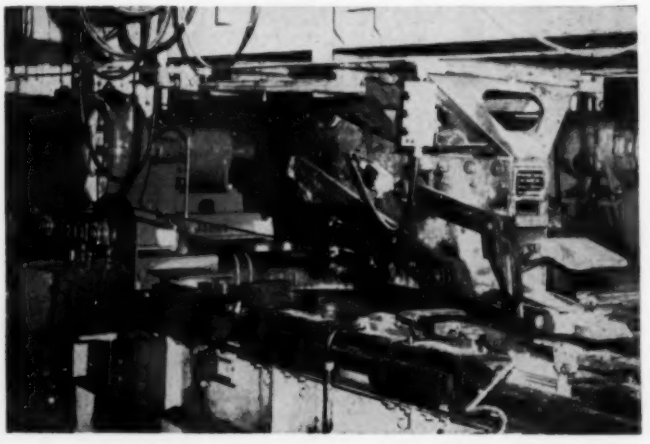


Figure 4 — The pull head has its own power pack for operation of the gripping jaws.



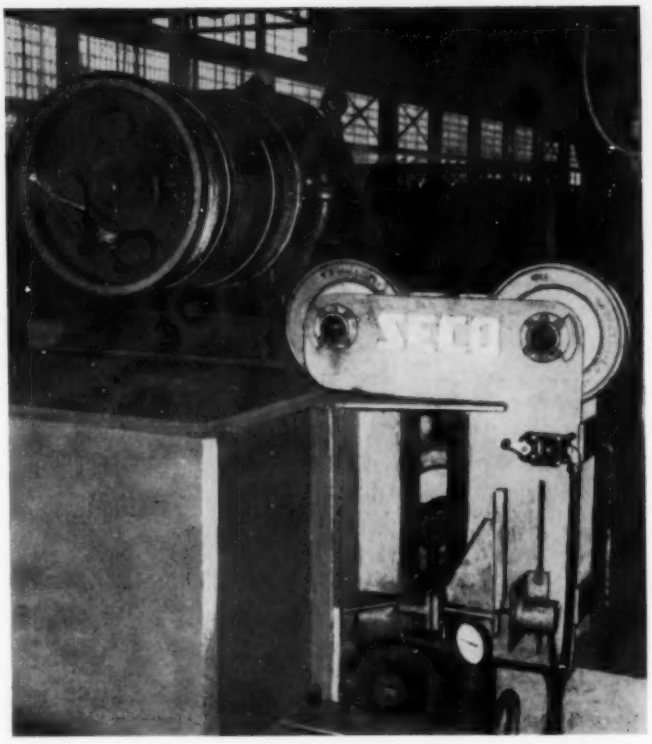
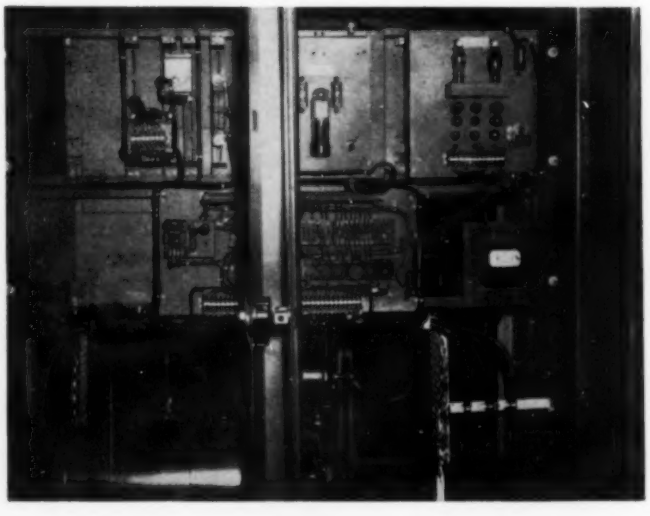


Figure 5 — The tension stand consists of two fixed guide sheaves and one movable sheave, a cam assembly which operates a short stroke regulator, and a pneumatic regulator system.

ARRANGEMENT OF ELECTRICAL EQUIPMENT

The drive motor receives armature power from its own packaged power unit, Figure 6. This is a compact variable speed control unit which houses the factory wired motor-generator set, magnetic control, and regulators. This unit has a sheet steel enclosure with a built-in filtered cooling air system. The "packaged" feature of the drive meant extreme ease of installation and a saving in installation cost. Location of the control unit is on the mill floor immediately adjacent to the press area so that cable runs were very short, puller operation could easily be observed from the control unit, and a communication system was not required between the puller and the control unit. This type of installation, using a "packaged" drive, did away with the need for a separate control room.

Figure 6 — The packaged power unit furnishes power for the drive armature motor.



The generator is provided with a single low-voltage shunt field, and both motor and generator are suitable for reversal by generator field. The generator field receives excitation directly from its control exciter which is equipped with two fields. An auxiliary field provides a constant 230-volt negative bias ampere turns, while the main field is excited by an electronic regulator. When the regulator output varies from 0 to 230 volts, the control exciter armature voltage will vary from −230 volts to +230 volts. This combination of control exciter and low voltage field of the main generator provides the ability to swing the motor armature voltage from maximum voltage in one direction to a maxi-

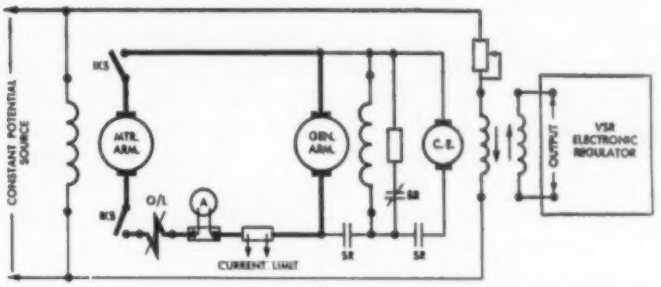
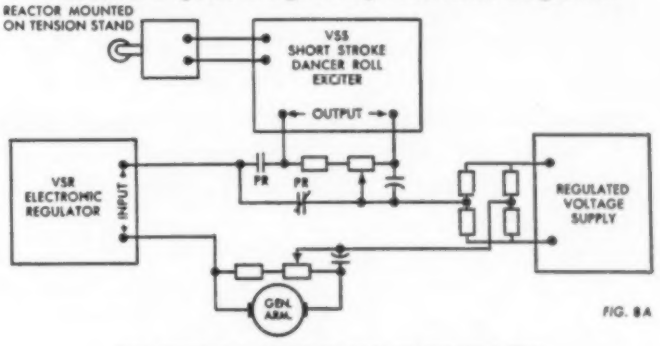
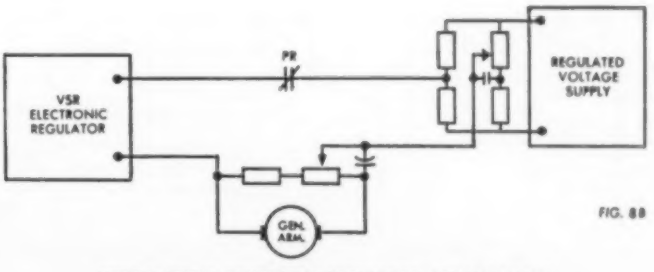


Figure 7 — A current limit feature in the regulator limits motor armature current peaks in transient conditions.

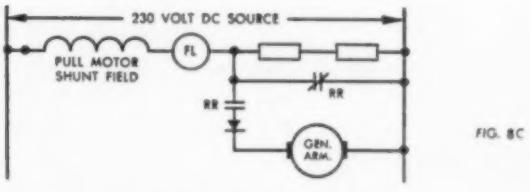
Figure 8 — Arrangements of regulator circuit during pull and return cycles are given by schematic diagrams.



PULL CYCLE GENERATOR REGULATOR ARRANGEMENT



RETURN CYCLE GENERATOR REGULATOR ARRANGEMENT



RETURN CYCLE MOTOR FIELD FADE IN CIRCUIT

mum voltage in the other to reverse the drive motor at an exceedingly fast rate. A current limit feature is incorporated into the regulator to limit the motor armature current peaks during a transient condition. Figure 7 shows the arrangement of the electric system.

During the pull cycle the regulator circuit is arranged as shown in Figure 8A. This system compares reactor position (speed) with generator voltage so that the system will attain a balance for a given extrusion rate at the set value of tension. The cam is designed to provide overtravel on both sides of the regulating range. Thus for transient conditions, the tension will be maintained at a given value, just as long as the air cylinder is not at either extreme position.

The air accumulator size was selected so that a full displacement or replacement of air would not change the air pressure more than plus or minus 2 per cent. A duo range regulator was used which provided a 5 to 125 psi regulated range. A standard gage with 4½-in. dial was used for tension indication. The tension stand air cylinder used was selected on the basis of minimum overall friction and equal friction in both directions. Chrome plated parts and an adjustable packing gland were incorporated.

An analog computer study was made of the complete electro-mechanical system and was used for the tension stand design check and review. The computer study indicated that the desired performance would be well within the specified tolerances both from a stability standpoint, and from the standpoint of ability to maintain preset tensions. Actual operating experience has substantiated these predictions.

OPERATIONAL CONSIDERATIONS

There are two distinct operating cycles that are required: the pull cycle, and the return cycle. The pull cycle is initiated by the operator who also manually controls the press operation. The pull cycle can not be started until the extrusion is successfully clamped in the pull head.

Once successfully clamped, and tension applied, the operator initiates the press extrusion cycle. The puller will continue to apply tension until it is manually or automatically removed when the extrusion is sawed off at the end of the extrusion cycle.

Tension can be adjusted by the operator at any time by adjusting the air accumulator pressure regulator. Because the receiver is necessarily large to reduce air displacement variables during transients, the change in regulator setting requires several seconds before the accumulator is regulated at a new value.

With all of the variables injected by the operator, plus the differences in materials and die chilling, the accelerating characteristics will change from piece to piece in a somewhat unpredictable manner. These factors rule out the more desirable current (torque) regulating system because of the inability to pick up a rate of change signal for WR^2 inertia compensation. From actual production checks, the worst condition required is a 50 per cent operating speed change in 0.5 sec. This was used as the basis of the preliminary analog computer check during the design stages of the drive.

The return cycle is initiated by the operator's press-

Figure 9 — Curves give data for current tension versus tension stand dancer roll displacement.

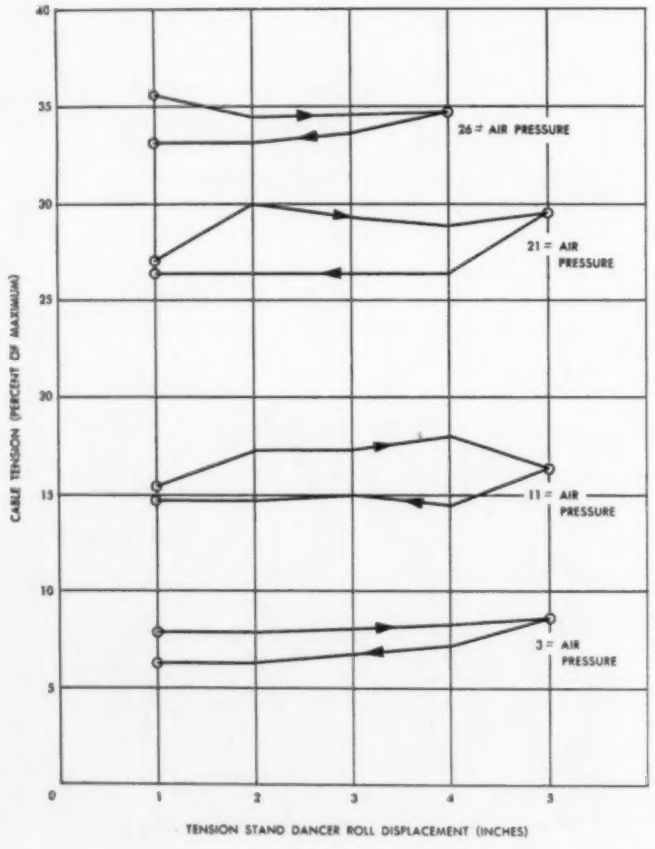
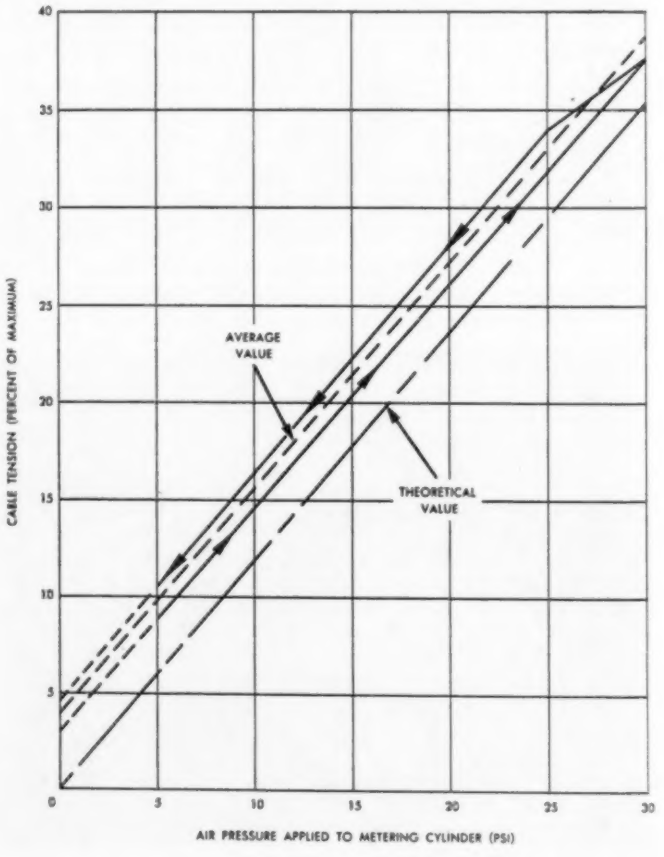

26 = AIR PRESSURE
21 = AIR PRESSURE
11 = AIR PRESSURE
3 = AIR PRESSURE
CABLE TENSION (PERCENT OF MAXIMUM)
TENSION STAND DANCER ROLL DISPLACEMENT (INCHES)

Figure 10 — Cable tension is proportional to the air pressure applied to the tension stand metering cylinder.



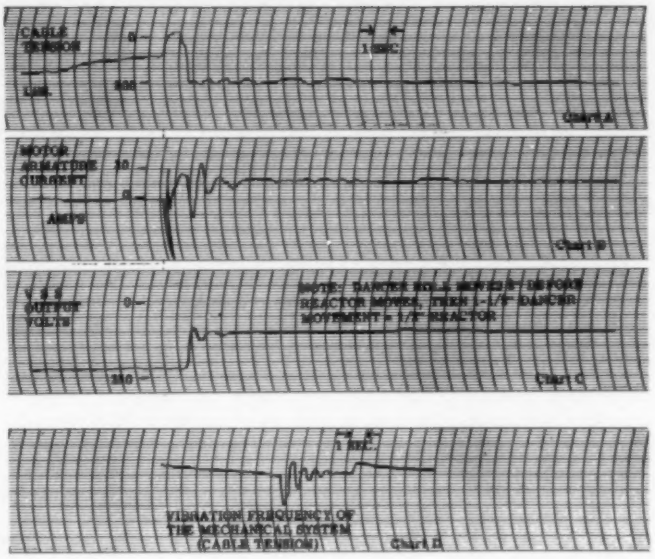


Figure 11 — Chart gives data for worst operating condition which is going from condition of slack cable to stall.

ing of the "return pull head" pushbutton. This is a non-productive part of the cycle and must be accomplished just as rapidly as is practicable. The maximum return speed is accomplished at maximum reverse generator voltage and weak motor field, and is slightly in excess of four times maximum pull speed. This is brought about by two simple circuit modifications. Figure 8B shows the generator field regulator circuit modification and Figure 8C shows the motor field "fade-in" system of field weakening. The control provides current limit for the acceleration and deceleration periods.

The pull head will continue to return at high speed until the operator presses the "pull head stop," or until the pull head trips the limit switches at the cycle starting position. The first limit switch tripped is the "slow down" switch which causes the pull head to come to a regulated slow speed. The pull head will then creep into the initial starting position, at which position the "stop" limit switch is tripped, bringing the drive to a suicide stop. Actual operating experience has shown that the final stop position can be repetitively maintained within plus or minus $\frac{1}{8}$ in. In this position, the pull head is ready to receive the next extrusion.

OPERATIONAL OBSERVATIONS

Since the puller has been put into operation, production schedules have limited the amount of test data that has been taken, but several checks have been made on various phases of operation. One check concerned the actual cable tensions obtained with dancer roll displacement for a constant air pressure, Figure 9, and shown in composite, Figure 10. These graphs indicate the importance of having an air cylinder that exhibits an absolute minimum friction. The charts are taken for the lower third of the tension range, and when carried to the maximum range, the same band width of friction error applies. From a percentage consideration, this will be two per cent at full tension, and six per cent at one-third tension.

A second set of data was taken, which recorded the worst condition the drive had to satisfy: going from conditions of slack cable to stall, Figure 11, Charts A, B, and C. Chart D, Figure 11, shows the mechanical frequency of vibration. This was obtained by applying tension to the cable under static conditions, then displacing the cable by a weight which was suddenly released to set the cable into vibration. The results would indicate a potentially unstable system but under actual operating conditions, the magnitude of this vibration is greatly amplified when moving from slack to stall conditions. With the high gain fast system utilized, a high degree of stability was obtained without sacrificing speed of response. It has been observed that all other transients are satisfied within the operating portion of dancer roll movement and they do not move into the overtravel provisions. The cable tension plots for all observations were made by the use of a strain gage mounted in the cable linkage which indicated actual pull tension exclusive of cable weight and dancer roll tare weight.

The puller drive has proven itself in actual operation, and has verified the extensive electro-mechanical analog computer studies made in the initial design stages. This ability to predict actual operating results before final design and construction makes it possible to apply correct equipment for any press application for which complete operating ranges can be predetermined.

This same ability to predict has produced satisfactory drives in other fields, such as on wire drawing machines, dancer-roll controlled spoolers, and tensiometer controlled reel drives. Such results are only possible with full cooperation between the user, the machinery builder, and the electrical supplier.

DISCUSSION

PRESENTED BY

E. R. JOHNSON, Chief Electrical Engineer, Dow Chemical Co., Madison, Ill.

M. D. STONE, Manager Development, United Engineering & Foundry Co., Pittsburgh, Pa.

R. C. SUTTLE, Application Engineer, Metals Division, Reliance Electric and Engineering Co., Cleveland, Ohio

R. M. REICHL, R. M. Reichl Co., Forest Hills, N. Y.

F. H. WICKLINE, Electrical Engineer, National Tube Division, United States Steel Corp., Pittsburgh, Pa.

E. R. Johnson: It is rather gratifying to hear this excellent paper on the problems we have had in Madison for some time. Puller drive systems are not new. We have been using them for some years, and recently we put into operation this drive which has met all of our expectations in performance.

We have other drives of a similar nature where a spring loaded dancer roll is used; however, we have had a considerable amount of trouble stabilizing the system, and to date we have been unable to get sufficient feed back to stabilize the unit under extreme transient conditions.

We have a drive that was mentioned by Mr. Suttle—the current regulator type. There again we have considerable trouble to obtain satisfactory inertia compensation, especially under low tension conditions and rapid rates of acceleration. The cable goes slack because more torque is required by the motor to accelerate the cable drum and the armature than is required to pull the tension.

We are in the process of obtaining a drive to use on our heavy press program that is, electrically, basically the same drive. The only exception is that we have gone to the spring-loaded dancer roll rather than the air system as indicated in this paper, even though we appreciate that this will cause a greater transient of error. However, with the size of the press and the product being produced, we feel that the rates of acceleration will be slow enough so as not to exceed our tolerances.

The drive as outlined by Mr. Suttle has been in operation for almost two years and we have had very little, if any, trouble at all. One problem, as he pointed out, was this friction and if and when we build another drive, the only change we feel we will make is to invert the air cylinder so that the air pressure will be opposite the piston rod, and thus we can use a ball bushing instead of a piston rod packing to help reduce the friction.

M. D. Stone: I would like to ask the author is it necessary to stop the extrusion process in order to grip the front end of the extrusion or do you try to grip it on the fly?

Secondly, what speed of extrusion have you operated the motor and is it used on rods or tubes and what size?

In trying to interpret the charts, it seemed to me I saw 125 volts, 10 amperes and 800 pounds. That would be something like a couple of horsepower and, as I remember, you said you had a 15-hp motor on the unit.

R. C. Suttle: The puller is designed for the press to be stopped at the time the extrusion is clamped. Normally, the practice has been to use a billet size that will afford the required length of extrusion and provision was not made for catching the extrusion on the fly. It could be done, but would require additional equipment not included here. The speeds of operation can be obtained from Dow Chemical Co. I think that Mr. Johnson would be able to elaborate more on the selection of horsepower and the speed of the puller.

You are correct in your interpretation of the charts. We did point out that the values of tension were somewhere in the neighborhood of one-third of the machine rating.

E. R. Johnson: As you know, the extrusion press is a rather versatile piece of equipment and this particular unit is on a 5500-ton press and we can extrude many from about eight or ten-in. diam down to rather small sections. The drive has to be versatile enough to cover this range of product, in normal operation. We do operate most of the time down at the lower tension ranges, and that is why the test data was taken at this particular point.

R. M. Reichl: I would like to ask Mr. Suttle if this device has been used for the extrusion of two or three strands. I have another question, concerning straightening. I believe I understood the sections are rather straight when they come from the press. Are they straight enough, i.e., commercially straight?

R. C. Suttle: Basically, this system was designed for a single strand operation. The larger press that is now being built is designed for two strands and incorporates a differential tension unit, so that differential lengths can be pulled at the same tension value. If we went to an extreme number of strands, the ability to get the extreme differential lengths would have to be obtained by the addition of several more tension equalizers of this same type.

If you will notice, the tubes that are shown in Figure 3 were very straight. It was pointed out to us that even these sections, which were on the cooling bed when the pictures were taken, were not as straight as had been attained. Simple sections do not require the final straightening operation, but the more complex sections may require a small amount of final straightening.

F. H. Wickline: Mr. Suttle, you mentioned that the acceleration requirements for that motor varied from piece to piece. Did you mean piece to piece in the same specification, or where you change from one schedule to another?

R. C. Suttle: When we mention unpredictable manner, the comment is actually made with reference to a given extrusion cross section and a given size of billet for a production run. This statement is made because, even though the piston of the press advances there is a time variable between the time that the piston engages the billet and the time when the extrusion starts. The retainer ring where the metal is being put under stress must be filled before the metal will start flowing and you can readily appreciate that this cannot be controlled.

As a result, there is a period when the metal will not flow. This does not follow any particular pattern, and as a result we do get a variable from this phase of operation. The heat of the billets, although temperature is controlled very closely, is also not exactly the same from billet to billet.

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ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BLDG., PITTSBURGH 22, PA.

By A. C. STOEVER, Superintendent of Utilities, Granite City Steel Co., Granite City, Ill.

Modernization of an Industrial Plant Distribution System

. . . . as steel plants expand and combine operations, provisions must be made to furnish adequate power . . . . dependable operation must be designed into the system, and to complicate the problem provisions must be made to minimize penalty clauses in power contracts . . . .

▲ IT might be of interest before discussing the recent modernization of the electrical generation, purchased power and distribution system at Granite City Steel Co. to discuss briefly the early beginnings, not only of electric power, but also of the steel mill operations of earlier years. While the company was founded in 1878, its operations at Granite City began in the middle '90's with a few small steam-driven mills which produced principally plates and sheets. The power plant of that day consisted of three 100-kw belt-driven dynamos generating 230 volts, d-c, and one 2300-volt single phase alternator. The alternator supplied street lighting for the new town of Granite City, and for a short period supplied a few commercial establishments such as barber shops and saloons where two or three sixteen-candle power carbon filament lamps constituted modern lighting for that day. These units were driven by belts from a line shaft, which in turn was driven by belts from a steam engine. The d-c power was used for general lighting, a few motors and operation of overhead traveling cranes.

With the growth of the company came the need for more electric power which was supplied by direct connected Corliss engine-driven d-c generators, which by 1914 had attained sizes varying from 300 to 500 kw and totaling four in number. The growth of the company during World War I was accompanied by the need of still more electric power. There were here as in many other steel mills, large steam engine-driven rolling mills, the exhaust of which was discharged into the atmosphere. There was accordingly completed in 1919 a turbine room containing one 3000-kw, 2300-volt, 3-phase, 60-cycle mixed pressure steam turbine. This plant with its remote controlled switchboard, and numerous other features very common today in power plants, was an installation of which its designers and the company were justly proud. A second 3000-kw duplicate turbine was installed in 1920. These turbines carried as much as 60 per cent of their rated load on exhaust steam secured from the rolling mill engines then in operation. While there had been a 2000-hp, motor-driven bar mill installed at the same time that the first turbine went in, a great part of the output of this station went to the d-c load in the plant for which reason there was installed with the first turbine two 1000-kw motor-generator sets. After the second turbine was installed, the old d-c power house was shut down although it was retained as a reserve unit for a number of years.

In the early 1920's, a new sheet mill was built which was driven by a 2500-hp, 2300-volt motor. Almost immediately afterward, a new three-high plate mill was installed, driven by a 3000-hp, 2300-volt motor. While purchased power sub-stations were installed for each of these large motors, it was found possible to carry the plate mill on the company's turbine plant. The sheet mill operated on purchased power for almost fifteen years. It might be of interest to note that in spite of this substantial beginning of the use of motor-driven mills in the early '20's, the twenty steam engine-driven tin mills did not cease operations until 1937 when tin plate production was rolled on reversing cold mills installed a year before. The operation of the steam-driven blooming mill ceased in 1937 after the sheet bar rolled on this mill began to be produced on the 90-in. hot strip mill which was installed in 1936. The last survivor of the steam-driven mills, namely a two high reversing slabbing mill, was not discontinued until 1953 when a modern bloomer was completed.

With the installation of the hot strip mill and the reversing cold mills in 1936, a decision had to be made as to whether the large additional amount of power required would be generated or purchased. Economic studies dictated the installation of additional generating equipment. Steam generating facilities installed in 1927 for eventual 425-psi operation, but initially operated at 160 psi, were available with but minor changes, to supply steam to two 7500-kw steam turbine units which were installed in an extension of the 1919 turbine room. This provided an installed capacity of 21,000 kw. The new generator voltage was selected to be 6900 volts, and the motor-generator sets supporting the hot strip mill and the reversing cold mills were made 6900 volts as well. By means of a 2.3 to 6.9-kv, 7500-kva tie bank of transformers, the four turbines were operated in parallel. Thus the feeders to the new mills were 6900 volts, with the older feeders remaining 2300 volts.

When the two 7500-kw steam turbine units were installed in 1936, it was necessary to protect the older oil circuit breakers on the 2300-volt feeder circuits

from breaking the fault currents which could be supplied by the additional 15,000-kw generating capacity. The machine breakers for the 1936 installation as well as the various distribution breakers were all of a modern metal-clad design having an interrupting capacity of 500,000 kva including the tie breaker to the original 2300-volt bus. Each of the older feeder breakers was equipped with instantaneous over-current relays in addition to the existing inverse time-delay relays. The instantaneous relays were set so that a fault amounting to 400 per cent of the feeder rating would trip the instantaneous relay which blocked the opening of that feeder breaker, but opened the tie breaker to the old bus structure, thereby cutting off the contribution of the two 7500-kw units to this fault. A "b" contact in the same breaker also opened the machine breakers of the two 3000-kw units. This, of course, resulted in a complete failure of the 2300-volt system, but the flag on the instantaneous relay of the faulted feeder gave immediate indication as to which feeder should be cleared, after which the tie breaker could be reclosed and the 3000-kw machines synchronized back. While this would seem to be a rather extensive disturbance, it happens quite infrequently and does permit continued use of the older low-interrupting capacity switchgear, the replacement of which would be quite costly.

While there was never any continuous parallel operation of the company's plant with the utility under any of the several purchased power installations which existed at various times, there were means available whereby under distressed conditions the unit supplied by purchased power could be kept at least in partial operation from the company's plant. However, as a means of getting the steam generating plant started in event of a generated power failure and during periods when there was no purchased power available, there was installed in 1937, a 300-kw gasoline engine-driven alternator which was a priceless piece of equipment on numerous occasions. Purchased power for the sheet mill was discontinued in 1937, and the plant remained an isolated power operation again for some seven years. For precautionary reasons, purchased power as well as company generated power was provided for the open hearth plant built in the early '40's by the Defense Plant Corp., the normal source of power is the utility.

The period beginning immediately after World War II found the company in a position of needing far greater rolling capacity for tin plate and light gage sheets for which reason a four-stand, cold reduction mill was installed in 1947. The power requirements of this unit, which was supported by a 12,000-hp motor-generator set, was beyond the ability of the 21,000-kw plant to handle along with the remainder of the mill load, so purchased power was again contracted for, to handle this mill through a company owned substation. The 69-kv power was received, stepped down to 6.9 kv and delivered to the single 12,000-hp motor. Power for all auxiliaries to this mill, including even the switching power for the substation and 12,000-hp motor, was taken from the company's plant.

In 1951, the company embarked on an expansion program which made it a completely integrated company, provided additional open hearth capacity, made available a modern blooming mill, and provided a modern four high reversing roughing stand at the hot strip mill. These facilities have increased the company's annual ingot capacity from 700,000 tons to 1,200,000 tons per year. The company became fully integrated when it acquired the blast furnaces and coke ovens located a short distance away from the steel works. These had been rehabilitated by the Defense Plant Corp. as a part of the World War II ironmaking expansion. This property was built during World War I, but lay dormant during the depression years of the '30's. Its power supply is completely separate from that of the steel works, and as a matter of fact, is actually a utility-owned and operated station receiving certain fuels from the company and furnishing steam, electric power and other services necessary for the operation of the blast furnaces and coke ovens.

The new facilities provided in the steel works required about double the capacity of the 21,000-kw power plant already in use. Since further extension of that plant or the building of a new power plant was not economically feasible, a purchased-power contract was negotiated with the utility for the additional power requirement. This contract provided for parallel operation of the 21,000-kw turbine installation at the steel works with the utility. From the standpoint of the utility, it was desirable that the company absorb with its own plant, as much of the load swings as possible. The separate source of purchased power which had been used to supply the cold reduction mill since 1946 was combined into this new parallel-operation contract. A substation was built containing three new 20,000-kva transformers, one of which supplies the blooming mill and two are used to supply the hot strip mill. The 12,000-kva transformer bank, which formerly supplied the cold reduction mill, was used to tie the 69-kv bus in the transformer substation to the 6.9-kv bus in the power plant. Thus, when the company's power plant absorbs a part of the load swing of the hot strip mill or blooming mill, it does so by transforming the 6.9-kv generated power to 69-kv and back again to 6.9-kv. While this involves transformation losses, other advantages far more than offset these losses.

The utility can at present supply something over 1,100,000 kva into a fault which could develop inside the plant with future possibility of nearly 2,000,000 kva, for which reason it was decided to make the incoming line breaker, as well as the 69-kv breakers on the high side of the transformers 2,500,000-kva interrupting capacity. There are older feeders extending from the 6.9-kv power house bus to the hot strip mill which can be used in an emergency with some restrictions on load. The 500,000-kva interrupting capacity of these breakers is a recognized hazard at any time when they are put in service. There is also a tie between the hot strip mill and blooming mill 6.9-kv buses of sufficient capacity so that any one of the three 20,000-kva transformers can be cut out of service and the hot strip mill and blooming mill operated as a combined unit, again with some restrictions on load. The blooming mill end of this tie line was equipped with a 6.9-kv air blast circuit breaker, of 500,000-kva interrupting capacity, which same design of breaker was used throughout the new blooming mill, and in all additions to the hot strip mill bus. Extensive relaying was em-

ployed for overload protection, differential protection across transformer windings and for the 69-kv transformer yard bus. Upon failure of purchased power, which does happen occasionally, the company's power plant would attempt, of course, to carry the entire load. To prevent bogging down of the generating facilities, the tie line from the power plant bus to the transformer yard bus has directional over-current relays which open this tie when the power flowing into the transformer bus becomes excessive. This dumps the hot strip mill and the blooming mill, but immediately after such an incident, the power house operator recloses the tie which permits the operators of the hot strip mill and the blooming mill to restore essential things such as furnace fans, mill supply sets for cranes, lighting, etc. No rolling is resumed until the Granite City Steel utilities dispatcher authorizes it.

There are several points where it becomes necessary at different times to synchronize the company's generating plant with the power company. At all such points, the oil circuit breaker control switch is interlocked with a synchroscope switch. Whether an unplanned interruption or a planned interruption for maintenance purposes, the switching which needs be done to parallel the utility or isolate from them is invariably accomplished smoothly and speedily.

Parallel operation with the utility in addition to power flow, overload protection, interruption troubles and restoration of parallel operation always brings another problem. This is load control. Obviously, when an industrial power plant is paralleled with a utility, the stable frequency of the utility causes the industrial plant to operate base load and all load swings are supplied by the utility. To permit the industrial plant to take any portion of a swinging load makes it necessary that the control of the steam admission valves to the prime-mover be taken away from the speed governor and turned over to a servo-motor which is responsive to the swinging load. Such apparatus is not common, yet has been employed in numerous instances where this particular problem has arisen. In this installation, an especially designed apparatus was provided which essentially measures the power on the incoming line as well as the power generated by the turbines in the company's power plant. This automatic turbine load regulator causes the company turbines to carry a predetermined and adjustable percentage of the total instantaneous mill load. In addition, the regulator provides a means of loading the company turbines to an adjustable base load. Other features provide for adjusting the division of generated load between the various company turbines and for reducing both base load and per cent of total load in event the boiler pressure falls below a predetermined level. Charts give load in kw on the company's power plant, purchased power and total power, all simultaneous records. The functioning of the turbine load control has been very successful.

The nature of the contract made with the utility, as is customary, made it imperative that demands on them be very carefully watched. For this reason, as well as certain other useful functions which he could perform, the company made arrangements to have its own utilities dispatcher on the job at all times. His headquarters are in the utilities department office, remote from the power plant and the mills. He has before him various flow diagrams of the electric power circuits, water supply pumps, pipe lines and fuel flow diagrams. The three graphic meters showing the electric load on the company's generating plant, the power company and total plant load are provided over his desk. A recording demand meter on the purchased power is also available to him. The electrical system board, the dispatchers' panel board, the water system board and the fuel system board are all on the walls of his office, and in his full view. They are made of sheet steel with power lines or pipe lines applied in colored scotch tape. Alnico magnets, also colored, are placed on the boards to indicate switch positions: open, closed, or tagged-out, with similar designation for valves. Similar magnets show on the fuel board what furnaces, soaking pits or boilers are in operation, and what fuel or fuels are being used on them. By keeping these boards posted up to the minute, a comprehensive picture can be had by giving them a quick glance.

In the course of limiting demands, rather elaborate provisions are made to prevent the demand from exceeding the desired value. Demand intervals are kept synchronized with the quarter hours on the clock. An alarm alerts the dispatcher three minutes before the end of each demand period. A first stage contact in the demand meter, set 4 per cent below the maximum demand intended to be tolerated, initiates a timer which at the end of a forty-five second interval unloads the hot strip mill unless the operators of the mill respond to the dispatcher's call to cease rolling, made over a private dial telephone system direct to the operating pulpit of the mill. A second stage contact in the demand meter set at 2 per cent below the maximum demand intended to be tolerated, unloads the hot strip mill without any warning. This unloading of the hot strip mill consists of tripping the d-c breakers between the 650-volt, d-c bus and the motors of the five finishing stands of this mill. It does not interfere with the operation of the motor-generating sets which back up this d-c bus. After the hot strip mill is thus unloaded by either the first or second stage contacts, the operators of the mill cannot restart until the dispatcher depresses the reset button on his panel board which permits the mill operators to reclose a control relay at the mill and resume rolling.

The recording demand meter on the dispatcher's board is actually an impulse type meter receiving impulses from the watt-hour and reactive watt-hour meters mounted on the power house switchboard in parallel with the power company's revenue meter, which is a recording type with contacts duplicate of those in the dispatcher's meter. There are thus two chances that the alarm and time-delay unloading as well as the ultimate tripping-off of the mill will occur when the demands reach first stage or second stage values. The graphic watt meters, which produce the load charts, are available both on the turbine room switchboard and on the dispatcher's board by means of telemeter circuits. Along with the power company's revenue meter, the control of all circuit breakers in the 69-kv substation is located together with indicating instruments on the turbine room switchboard, so that all switching operations at the substation can be done by the turbine room operators.

In selecting the hot strip mill to be the load-light-

ening unit when power curtailment is necessary to limit demand, a large high-production unit is being interferred with, but the frequency of the interruptions for this reason is low and the duration of the interruption is usually limited to one or one and one-half minutes. Knowledge of mill operations enables the utilities department to schedule sufficient boilers and turbines to stay within the desired limitations in the use of purchased power. Under conditions of extreme distress, such as a puchased power failure, the dispatcher has on his private telephone system, lines to each of the larger power using units, which phones incidentally, are without dials so that they cannot be used for outgoing calls and are available at all times for incoming calls. Relays and sirens are also provided on these telephone stations so that calls will be immediately recognized. The private system also reaches the boiler room, turbine room and coke plant gas booster station.

The contract with the utility provides that the monthly load factor on their line be equal to or greater than that on the company's generation station. In event that this condition does not prevail and the load factor on the power company's line is less than that on the company's plant, it is provided that the utility may add kwhr not used to their metered kwhr to bring the load factors to an equivalent basis. While there are possibilities for the company to recoup such charges in subsequent months for kwhr not actually used, it is most desirable that the penalties be not incurred. Therefore, cumulative load factor calculations are made daily and purchases and generation adjusted accordingly. Limitation of demand actually takes preference over load equalization, since excessive demand charges are more costly and not recoverable.

The expansion program of the Granite City Steel Co., which required this increase in power facilities, was completed in September 1953, and the facilities for paralleling the company's turbine plant and the utility have met almost every conceivable condition. There has been a partial failure of the boiler plant wherein a 400-psi boiler blew a tube. There has been a failure on a 7500-kw turbine wherein a machine lead faulted. In both instances, the availability of the dispatcher and the prompt action which he took in reducing the mill load, averted extra demand charges on the power company amounting to about $10,000, which would have ensued had the hot strip mill continued to operate even for a single fifteen-minute period after these failures of the company's plant.

There have been several failures of purchased power, some of them quite a few hours duration because of the fact that the utility has provided only one incoming line, but except for momentary distress and complete interruption of rolling in the hot strip mill, they resulted in no interference with the remainder of the plant. It might be of interest to note the company's use of electrical energy, both generated and purchased, before and after the completion of the recent expansion program. In the few years prior to 1953, generation varied from 6,000,000 to 9,000,000 kwhr per month; purchases were 1,500,000 to 2,500,000 kwhr per month. In the latter part of 1953, with the completion of the expansion program, generation varied from 6,000,000 to 9,000,000 kwhr per month with purchases up to 5,000,000 or 6,000,000 kwhr. The maximum instantaneous load experienced before the completion of the expansion program was 27,500 kw generated and 8,000 kw purchased, and before parallel operation. Since parallel operation, the total plant load has reached a 48,000 kw maximum instantaneous value consisting of 26,000 kw generated and 22,000 kw purchased.

DISCUSSION

PRESENTED BY

L. G. LEVOY, Senior Engineer, Industrial Power Systems Engineering, Engineering Planning and Development, General Electric Co., Schenectady, N. Y.

A. C. STOEVER, Superintendent of Utilities, Granite City Steel Co., Granite City, Ill.

L. G. Levoy: One of the problems that often arises in modernizing older plants is that of system grounding. In the early days, many of the electrical systems were not grounded and this frequently caused trouble which was not recognized. If the system was not designed for grounding originally, sometimes special provision for grounding must be made at the time of modernization or expansion. I wonder if Mr. Stoever would care to comment on the method of grounding which is used in this plant on the various voltage levels?

A. C. Stoever: To begin with, we have of course, the usual run of every voltage conceivable, except 230 volt a-c. I think we can confine this to the a-c because our d-c systems are all maintained as free of grounds as possible. Our 2300-volt system which was begun in 1919, is ungrounded. Our 6900-volt generator system carries a ground. Our 6900-volt purchased power system is ungrounded. Our primary connection to the power company's transmission line is through a delta-connected transformer which does not permit the advantages of grounding relays on the incoming line.

We have had one or two instances where there have been ground faults far out on the transmission line supplying our plant. It is about six or eight miles long with a generating station at one end and a substation at the other end, backed up by more generating capacity. A fault on that transmission line is quickly disposed of by the power company. They have wye-connected transformers and ground relays, and when they "get off" the fault we then "own the fault," so to speak, and a heavy ground fault on a fairly small plant creates quite a disturbance. Our operators have learned what they need to do to cut loose, which they do.

We have just very recently had the idea of adding a frequency relay on our system. As long as we are tied to the power company, we have, of course, stable 60-cycle frequency, but if they cut loose of the transmission line due to a fault and we "own" it, we have a problem. Our frequency drops pretty quickly. Setting this frequency meter at 59½ cycles opens the incoming line breaker and clears us of that fault. This is the last thing we are looking for, but better than suffering a complete power failure.

Let me say for our 440-volt systems, we operate substations and they are all operated without a permanent ground.

Rolling and fabricating the many new metals which are required for the atomic energy program involved solution of a whole new series of unique and interesting problems . . . . special equipment has been designed for this purpose . . . . its operation necessitates special care to avoid radiation hazards . . . . knowledge is also required of the properties of the material in order to develop proper rolling techniques.

Rolling Mills for Processing Nuclear Fuel Elements

BY A. I. NUSSBAUM

Manager, Rolling Mill Sales, Stanat Manufacturing Co., Inc., Long Island City, N. Y.

▲ IN the past few years the rapid growth that has occurred in the application of atomic power has focused much interest upon a vital series of metal processing operations one of which is the fabrication of fuel elements for nuclear reactors. The successful utilization of the heat of the fission process for power generation and other industrial purposes largely depends on the proper design of the reactor core and its fuel element components.

In general, the basic fuel for a reactor consists of uranium 235 either in combination with uranium 238 as it occurs in nature, or in an enriched form such as that obtained from a gaseous diffusion plant. An increasing concentration of uranium 235 decreases the size of the critical mass necessary to produce a chain reaction. Uranium 238, a so-called fertile material, can be converted into a fuel by exposure to the neutron flux within a reactor. This reaction forms plutonium 239 which, in turn, can be separated and used as an atomic fuel. Similarly, thorium 232 can be converted to uranium 233 by the absorption of neutrons and subsequently can also be used as a reactor fuel.

FUNDAMENTAL DESIGN

Reactor designs have been classified by various standards. One of these standards of classification is based on the energy of the neutrons used to produce fission. Thus, the *thermal* reactor depends on low energy neutrons and uses a graphite or heavy water moderator to slow down the velocity of the produced neutrons. The *intermediate* reactor operates with neutrons of intermediate energies. Finally, the *fast* reactor uses neutrons of high energy in the neighborhood of 1,000,000 electron volts.

All the above three reactor designs may be of either the heterogeneous or the homogeneous type. In a heterogeneous reactor the fuel is in distinct shapes, such as rods, slugs, or plates placed in a solid or liquid moderator. In a homogeneous reactor the fuel material is mixed with the moderator, such as in a solution, and is distributed uniformly throughout the reactor core.

The core of a reactor is generally considered to be the most important part of the machine. It usually consists of a housing containing the fuel element arrangement, control rods and cooling facilities. Figure 1 shows the Geneva Experimental Swimming Pool reactor core with its cadmium control rods and uranium-aluminum fuel element plates separated by ordinary water acting as moderator and coolant. The design of a reactor core aims at facilitating the maximum possible rate of heat generation. Generally, the size and geometry of the reactor fuel elements are determined to suit the required heat transfer area within the core and the required volume of coolant and moderator. Thus, within the permissible limits of fabrication cost, the most desirable fuel element configuration will feature the greatest heat transfer surface per unit of core volume and per pound of fuel.

Since the Geneva Conference in August 1955, much information concerning nuclear fuel element design and fabrication has been declassified, and full-scale models of fuel element assemblies have been displayed by such concerns as Babcock & Wilcox, Metals and Controls, and Sylvania Electric Products at various expositions during the past year. The recent activities of

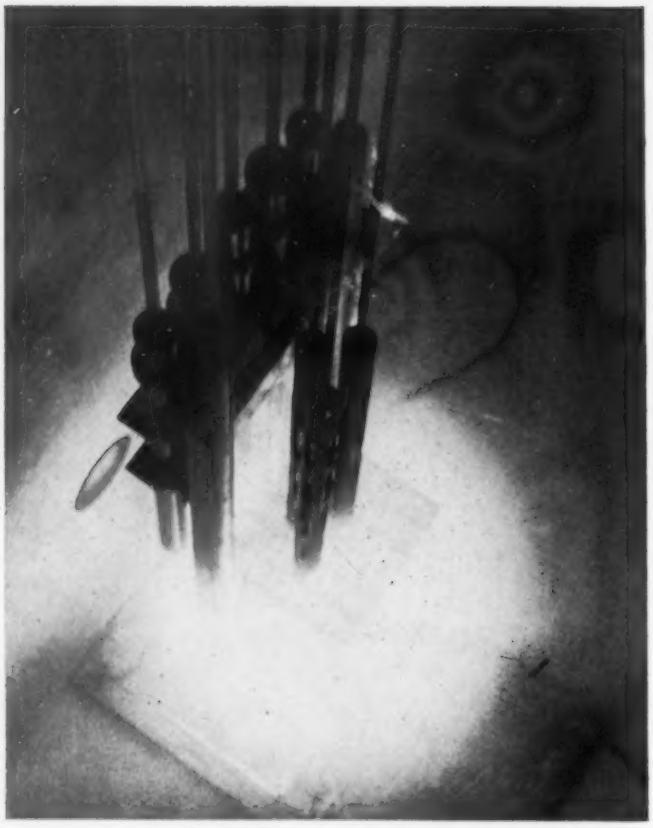


Figure 1 — In the swimming pool reactor, the fuel elements are separated by ordinary water which acts as a moderator and coolant.

these companies are representative of the current trend among private industrial firms to enter the fuel element fabricating field and to offer a custom design and fabrication service. As a leading manufacturer of steam generating equipment for the utility industry, it is a logical step for the Babcock & Wilcox Co. to enter this new field in order to be able to furnish the nuclear fuel to its customers constructing atomic power stations. The broad experience obtained by the Metals and Controls Corp. in the fabrication of both solid and composite metals formed an excellent background for the company to enter fuel element manufacture, and the firm's Nuclear Products Division has been engaged in this field since 1952. The Atomic Energy Division of Sylvania Electric Products, Inc., is today one of the largest single groups in this country exclusively engaged in the manufacture and development of fuel elements and components for atomic reactors. The company's broad experience in the metallurgy of high-purity, high-temperature materials has been a valuable basis upon which to build up its fuel element work, and since 1947 Sylvania has been active in nuclear projects for both the A.E.C. and private industry..

The original "know-how" in the design and fabrication of fuel elements was obtained in A. E. C. establishments, such as Oak Ridge, Argonne, Los Alamos, and Hanford, and much of this experience is now being applied to civilian atomic projects, such as the Indian Point nuclear power station of Consolidated Edison and the Dresden nuclear power station of Commonwealth Edison. The following five points are today considered of paramount importance in fuel element design:

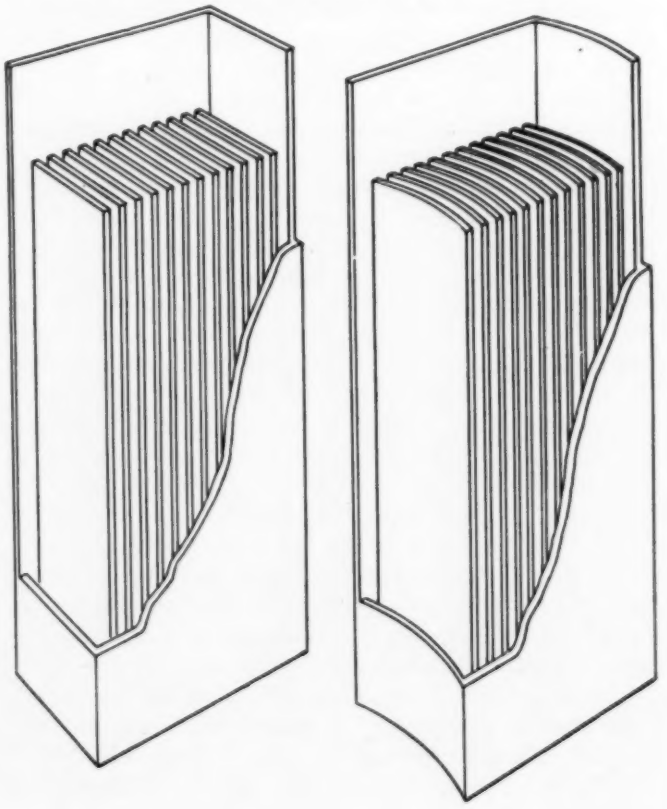
1. Proper geometry with high surface-to-volume ratio.
2. Simplicity of form combined with maximum mechanical stability.
3. Greatest degree of self-support with least amount of structural material.
4. Maximum corrosion resistance obtained by alloying or by cladding.
5. Low parasite capture cross section and absence of poison-forming tendencies.

To date, fuel element development has concentrated on plate and cylindrical designs, and this article is primarily concerned with flat shapes. The two configurations shown in Figure 2 may be considered to be the basic designs of flat plate elements. Such wide, thin plates give maximum heat transfer surface per unit volume of fuel; however, they may become mechanically unstable, and the resulting vibrations or distortions can produce failure of the elements. Applying a small degree of curvature to the plates improves the stability of the assembly, and this approach has been taken in the elements for such units as the Materials Testing Reactor (MTR) at the National Reactor Testing Station and the "CP-5" research reactor at Argonne.

BASIC MATERIALS

The fabrication of fuel elements involves two major groups of materials. The first group includes natural uranium, enriched uranium, plutonium and thorium, while the latter group includes aluminum alloys, zirconium alloys and stainless steel. While the early reactors constructed by the A.E.C. using natural or slightly enriched uranium generally employed slug

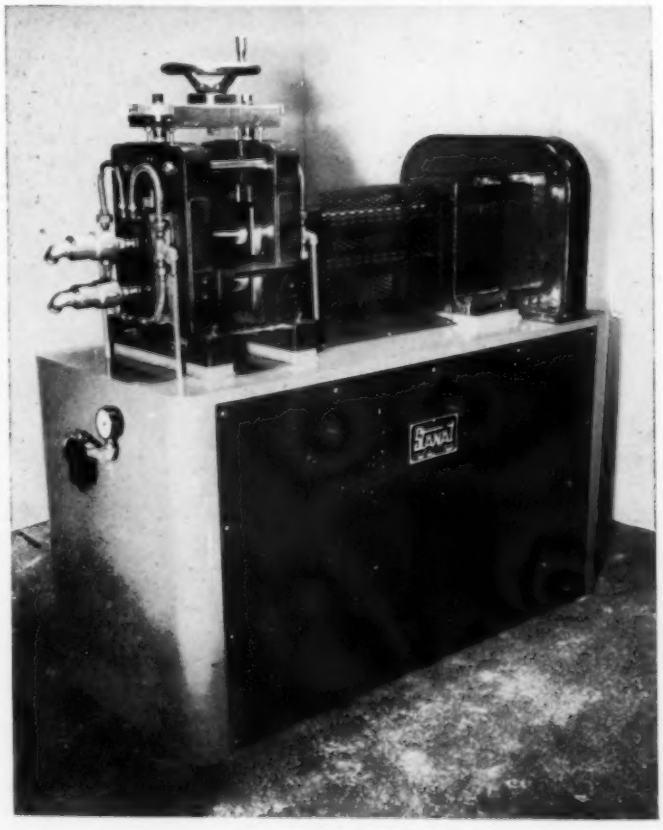
Figure 2 — The straight and curved plates are the two basic designs of flat fuel elements.



elements, more recent solid fuel reactor designs have replaced the canned uranium slugs by clad plates having a uranium alloy core and a bonded sheath of corrosion-resistant material, such as aluminum-tin, zirconium-tin or stainless steel. Another design now becoming popular is the dispersion type fuel element having fine particles of the fuel metal or its oxide dispersed in a metallic or ceramic matrix, such as UO_2 in aluminum or in beryllia. Aluminum alloy-clad fuel elements are limited to low-temperature applications up to about 400 F max. Zirconium alloy-clad units may operate up to about 1000 F max while stainless steel-clad elements could stand temperatures close to 1200 F. However, such iron-base alloys have the disadvantage of a high thermal neutron absorption cross section, which has to be compensated for by using enriched fuel. To cope with even higher temperatures, molybdenum and its alloys are likely to enter the fuel element picture. The Russian "Atomic Power Station No. 1" reactor, which generates about 30 MW of heat, employs 5 per cent uranium 235 enriched hollow fuel element cylinders enclosed in a metal jacket. It is believed that an alloy of uranium and molybdenum is used in this design, which, incidentally, shows excellent heat transfer characteristics.

Depending upon the design of the reactor, fuel elements may be required in a wide variety of shapes and configurations, including (a) flat, curved and corrugated plates; (b) solid and hollow slugs; (c) rods; (d) tubes; (e) plate, slug, rod and tube assemblies; (f) wire; (g) wafers; (h) pellets and spheres; (i) foil. In addition to containing uranium, thorium, and plutonium in metallic or compound form, fuel elements may involve a wide range of non-fissionable materials, including stainless steel, "Nichrome," aluminum, magnesium, zirconium, beryllium, titanium, nickel, chromium, copper, silicon, niobium, and molybdenum and their alloys. The latter materials are employed either in conjunction with the fissionable materials as an alloy, a powder metallurgical compound or a mixture in the fuel core, or as a cladding for the fuel to protect it from corrosive attack and to contain the fission products.

Figure 3 — The 2-high, 6-in. wide rolling mill is shown prior to installation in glovebox enclosure.



WORKABILITY OF MATERIALS

From a fabricating point of view, the manufacturer of fuel elements is very much concerned with the mechanical properties of the materials employed. An idea of the relative workability of the principal fuel element materials may be obtained from Table I which relates to annealed metal at room temperature.

TABLE I

Material	Ultimate tensile strength (psi)	Yield strength (0.2 per cent offset) (psi)	Elongation in 2 in., per cent	Young's modulus, (psi)
Uranium	120,000	52,000	11	26×10^6
Thorium (bomb-reduced)	33,000	23,000	26	11×10^6
Plutonium	classified			
Aluminum (2S)	13,000	5,000	45	10×10^6
Stainless steel (Type 302)	85,000	40,000	55	29×10^6
Zirconium (crystal-bar plus 2.5 per cent tin)	46,000	35,000	40	14×10^6

The majority of uranium fabrication is performed in the alpha phase and can be accomplished without difficulty. Initial ingot or billet breakdown rolling is generally done at elevated temperatures up to about 1100 F max. Finish rolling of sheet is usually performed on 4-high mill equipment, 90 per cent cold

Figure 4 — The enclosure of the rolling mill within the stainless steel and glass glovebox at the Los Alamos Scientific Laboratory is one of the unique requirements necessary in rolling radioactive materials.

reduction being possible without intermediate annealing.

Thorium metal of good quality is extremely ductile and may readily be hot rolled. Castings show a tendency toward intergranular cracking if cold worked directly and are therefore hot worked initially to break up the cast grain structure. Subsequently, the metal is highly malleable, and it is possible to obtain as much as 99 per cent reduction without intermediate annealing. The ultimate tensile strength of thorium is increased from 33,000 to about 78,000 psi by subjecting the metal to 90 per cent cold work. Although thorium is an alpha emitter, the processed metal has a relatively low activity level and is normally handled without protective clothing or shielding.

Both aluminum alloys and stainless steels are readily workable and allow total cold reduction of up to 90 per cent to be obtained. Zirconium and most of its alloys have adequate ductility at room temperature and permit a satisfactory degree of cold rolling. Total reduction between anneals of up to 80 per cent are feasible with pure zirconium and up to 50 per cent with an alloy containing 2½ per cent tin.

PLUTONIUM FABRICATION

Although plutonium 239 is not among the most radioactive materials, it has to be handled with extreme care, and the A. E. C. has established very stringent health protection requirements for its installations. The alpha particle has a relatively low penetration ability and can be stopped by a comparatively thin shield, such as the neoprene gloves employed in glovebox enclosures. The greatest danger at a laboratory or processing plant handling plutonium is the inhalation of plutonium-bearing dust. Plutonium entering the body is deposited primarily in the bones and is excreted very slowly; the time required for man to excrete one-half his body burden is estimated to be about 100 years. According to current knowledge, the maximum permissible total body burden has been set at 0.5 microgram, and plant ventilation requirements are such that the air must not show a plutonium dust content greater than 7×10^{-5} micrograms per cubic meter of air.

Much of the original plutonium fabrication work was done at the Los Alamos Scientific Laboratory of the University of California at Los Alamos, New Mexico. The extent to which this laboratory went in providing proper enclosures and ventilation is well illustrated by Figures 3 and 4, respectively showing the original commercially available 6 in. wide 2-high rolling mill and its ultimate "enclosed" installation at Los Alamos. The rolling mill forms part of an experimental fabricating facility, including other rolling, swaging, wire drawing and annealing equipment. It is fed and operated through the long rubber gauntlets which can be seen at the front of the stainless steel hoods. If the work pieces become too long to be handled inside the enclosure, extension boxes can be added in line with the mill pass line.

A salt bath furnace is available for heating work pieces inside the enclosure, and there is a small motorized crane for handling purposes. The rolling mill is driven by a 7½ hp variable speed drive situated outside the enclosure. It is equipped with a single hand-wheel screwdown, continuously circulating oil lubrication and needle roller bearings on the roll necks. Most parts may be removed from the enclosure by transfer into plastic bags temporarily attached to the enclosure. Subsequently, the bags are sealed off and packaged for shipment to the burial grounds.

Figure 5 — This 2-high hot breakdown mill is used for rolling fuel material billets at Lynchburg, Va.

ROLLING MILL PRACTICE

Since at this initial stage the quantities involved in individual fuel element fabrication orders are likely to be small, most companies entering this field desire to limit their capital investment as much as possible. Thus, while conventional metal processing practice may call for a 2-high hot breakdown mill, a 2-high cold intermediate mill, and a 4-high cold sheet finishing mill, the fabricators of fuel elements today generally prefer to use a single machine capable of handling their entire rolling needs, from the initial ingot to the final sheet. Hence, there arose a need for a precision mill capable of the widest possible range of ingot, bar, rod, and sheet reduction, available at a price within reach of a limited budget and compactly designed to fit into the often restricted space of nuclear plants and laboratories. The 2-high/4-high combination rolling mill has been developed to fill this need, and Figure 5 shows such an installation at the Babcock & Wilcox nuclear facilities plant in Lynchburg, Va., arranged for the 2-high hot breakdown of fuel material billets.

When functioning as conventional 2-high units, such mills have relatively large work rolls for breakdown of ingots and bars, reduction of strip requiring high luster, and for skin passing of annealed strip. Apart from power considerations, the determining factor for breakdown rolling is generally the maximum draft per pass that can be taken with the material entering the rolls unassisted.

The work rolls should be of relatively large diameter also for skin pass rolling of annealed strip, when a reduction of only about 1½ per cent is usually desired.

Such rolls are also advantageous for reducing strip with little or no lubricant so as to obtain a bright and highly burnished surface finish. This luster effect is directly due to the fact that the larger the work roll diameter, the greater the amount of slipping between roll surface and material.

Finally, the 2-high mill setup is still preferred for producing mirror-finished strip where extremely hard and close-grained rolls are used, super-finished to 1 to 2 micro-in., rms by lapping with diamond compound. In such ultra-precision work, it is not desirable to have a continuous line contact between the work and backup rolls, and the work rolls can be wiped with felt pads more readily in the 2-high design. Furthermore, a larger diameter work roll with its greater circumference will wear relatively less and thus perform better and longer between grindings.

FOUR-HIGH OPERATION

Almost every engineer or metallurgist using a 2-high strip mill sooner or later is blocked by the inability of his completely screwed-down mill to produce any further gage reduction. Even an additional intermediate anneal may be of little help, and the only solution is to continue processing the strip on 4-high or cluster mills having considerably smaller work rolls backed up by large supporting rolls.

The concept of a combination 2-high and 4-high mill was developed particularly to overcome this situation. It may be considered primarily as a 2-high mill designed so that the rolls can be raised sufficiently to insert between them a set of two small diameter work rolls. Alternatively, it may be regarded as a 4-high mill with driven backup rolls designed to facilitate rapid changeover to a conventional 2-high configuration by the withdrawal of the two work rolls.

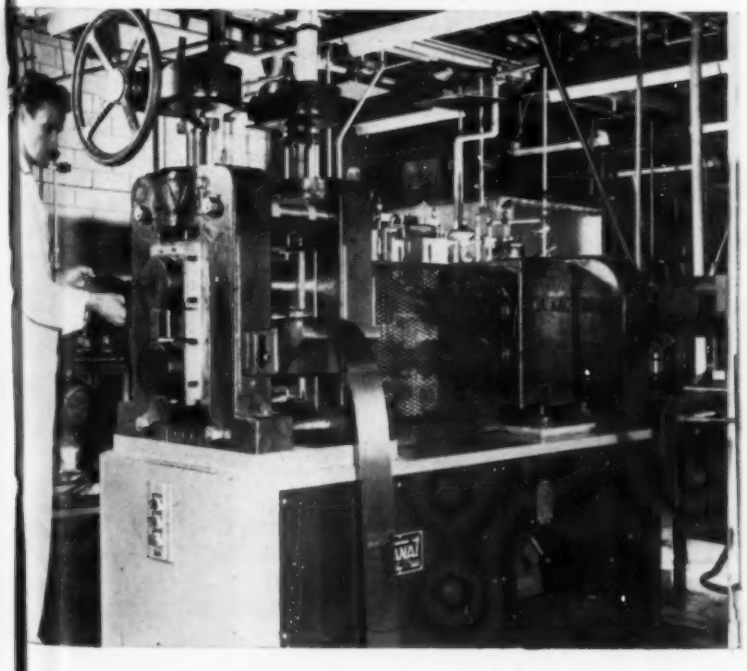
The object of all forms of backed-up rolling mills is to obtain the largest practical reduction in the diameter of the work rolls. Extensive research into the cold rolling of strip has established that—for a given material, reduction and width—the roll load, rolling torque, rolling horsepower and lateral spread of the strip decrease with the diameter of the work rolls. Consequently, for a mill of given roll load capacity and horsepower, greater reductions may be taken with work rolls of smaller diameter. The reduction in lateral spread with reduction in work roll diameter also has considerable practical advantage in rolling the harder metals and alloys since it reduces the tendency of the strip edges to tear or crack. The "stiffness" of the backed-up 4-high mill and the ease with which its small work rolls can be crowned have made it possible to produce extremely accurate strip with practically no gage variation across its width. Finally, a smaller work roll permits thinner strip finishing gages even in highly work hardened materials since the length of the flattened arc of contact between the work rolls and material—and, hence, the roll load and rolling torque—decreases with decrease in work roll diameter.

The roll load and rolling torque in a 4-high mill may be further reduced by employing tungsten carbide work rolls. Cemented tungsten carbides have a modulus of elasticity about twice that of steel and thus tend to reduce roll flattening to the very minimum. The 4-high mill with backup drive is particularly well suited for solid carbide work rolls; the roll shape is simple, the weight relatively small, and there is no requirements for torsional loads to be applied through wobblers.

The 4-high arrangement of an 8 in. wide combination rolling mill installed at the Atomic Energy Division of Sylvania Electric Products, Inc., Bayside, N. Y., is illustrated in Figure 6. Work rolls ranging from 1½ down to ¾ in. diam may be used in this machine, facilitating the reduction of strip thickness to less than 0.001 in. gage. The unit is driven at speeds ranging from about 30 to 185 fpm by a 15-hp motor mounted in the base. The mill housings have a cross-sectional area of 120 sq in., and the roll neck bearings can sustain a maximum separating force of 150,000 lb.

In an all-purpose mill of this type, there is much to be gained from driving the backup rolls rather than the work rolls. Despite the original objection to this method on the ground that slippage would occur between the work rolls and the backup rolls, extensive and successful service of 4-high mills driven by backup rolls has proved the soundness of this design. The backup drive eliminates one of the most serious disadvantages of the conventional 4-high mill with driven work rolls—namely, the limitation in torque that can be transmitted by the relatively small roll necks and spindles without exceeding their permissible torsional shear stress. This limitation is particularly serious with carbide rolls, which have a comparatively low torsional strength. Another valuable feature of the backup drive is its ability to overcome the lateral bowing-out of the small work rolls when heavy reductions with high front tension are taken. Driving the backup rolls causes a torque reaction on the work rolls which tends to bend them toward the entry side of the mill—that is, in the opposite direction to the force exerted by the coiling reel. By balancing this torque reaction and the strip tensions, the tangential force on the work rolls can be eliminated altogether. Finally, the backup drive allows

Figure 6 — This 4-high, 8-in. combination mill is rolling stainless steel strip necessary for fuel elements.



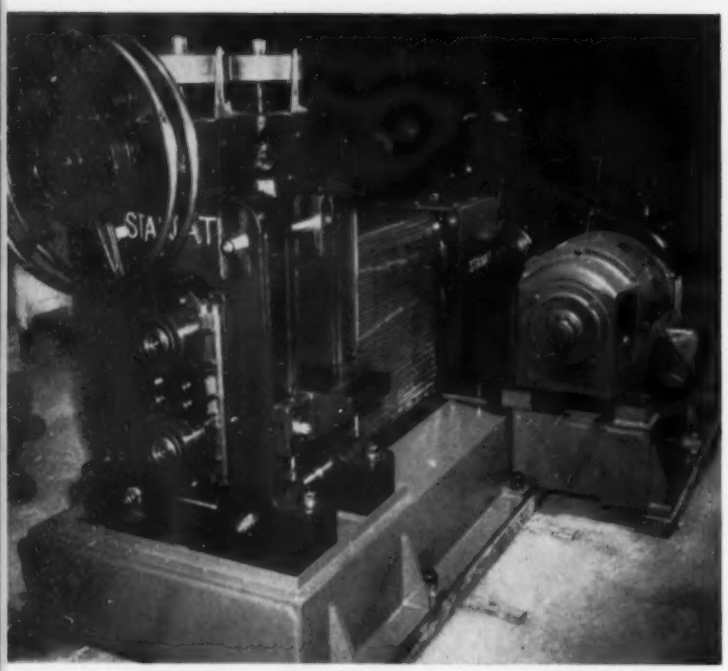
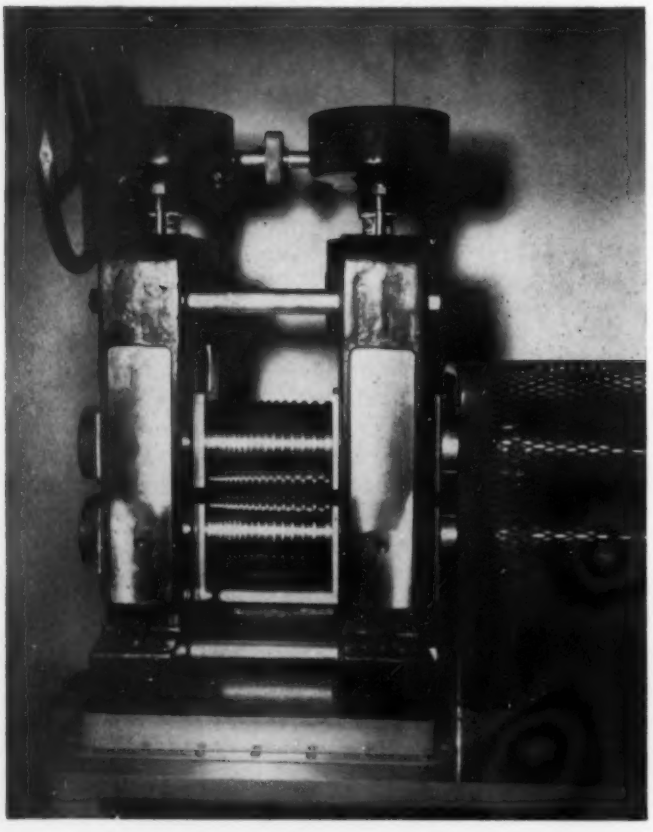


Figure 7 — The 2½ and 8 in. x 8-in., 2-high/4-high combination rolling mill at Hanford, Washington is heavier than many of the other units.

the diameter of the work rolls to be changed without changing the rolling speeds. As there is no need for universal spindles to be disconnected, the small work rolls may be changed quickly and easily.

A considerably heavier combination rolling mill installed at the Hanford Atomic Products Operation is illustrated in Figure 7. This machine has 8 in. diam backup rolls and can use work rolls within a 2½ to ¾ in. diam range. The cast steel mill housings have a

Figure 8 — The 8-in. wide combination mill is set up for 2-high hot rolling of round fuel elements.



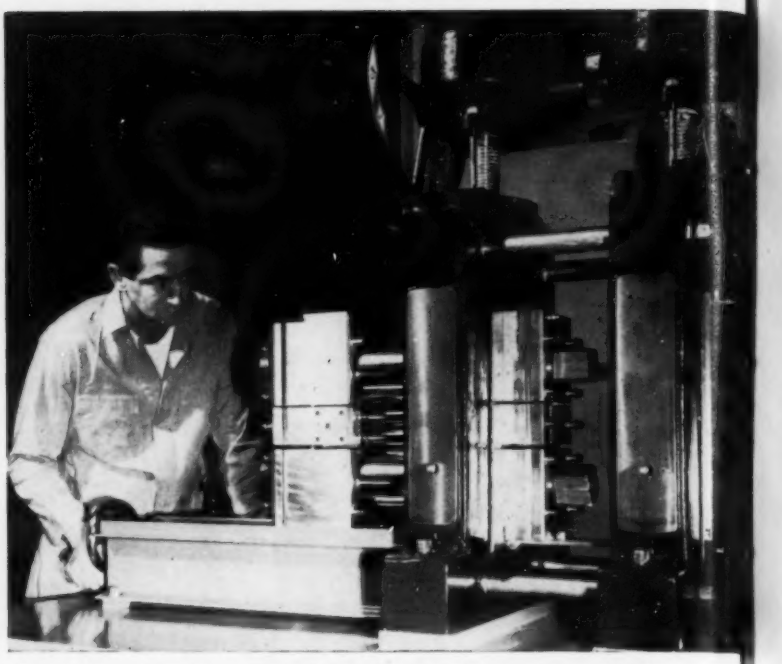


Figure 9 — Combination mill has a special remote control roll removal mechanism. Unit is shown before installation in glovebox at the Argonne National Laboratory.

cross-sectional area of 224 sq in., and the roll neck bearings can sustain a maximum separating force of 300,000 lb. The 30-hp variable speed mill drive furnishes constant horsepower over a 25 to 75-fpm rolling speed range.

In the fabrication of fuel elements of other than flat plate design, grooved rolls are frequently employed in the combination mill to obtain the cylindrical and other shapes required. The sizes of individual fuel slugs are generally quite small, and the ¾-in. diam x 6-in. long uranium slugs used in the sodium reactor experiment (SRE) facility of North American Aviation are representative of current practice in this respect. Figure 8 shows an 8-in. wide combination mill installed at the Aircraft Nuclear Propulsion Department of General Electric set up for the processing of such rounds.

GLOVEBOX ENCLOSURES

Figure 9 shows an interesting 2-high/4-high combination rolling mill equipped with a special remote-control roll removal mechanism and arranged to operate within a glovebox enclosure. This unit was developed originally for processing of alpha-active, pyrophoric materials at the A. N. L. Plutonium Metallurgy Research Laboratory and has subsequently also been installed at the Hanford Works of General Electric.

The design of the latest Argonne gloveboxes is based generally on a 36-in. long module and an inter-glove spacing of 18-in. The glovebox windows are made of clear, transparent, cast "CR-39" allyl polymer material, which has a high degree of resistance to scratching, impact, stress crazing and chemical attack. The gloves are made of neoprene, and polyvinylchloride transfer pouches are used to contain the plutonium pieces handled. The glovebox must be essentially gas-tight both to protect against contamination leakage and to maintain the desired inert gas atmosphere economical-

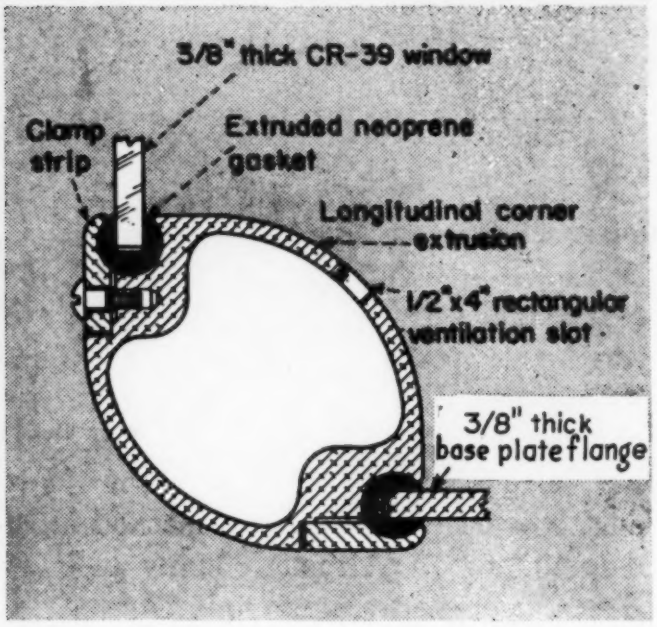


Figure 10 — Sketch shows extruded corner member used to clamp glovebox structure to rolling mill base plate at Argonne National Laboratory.

ly. In accordance with current practice at Argonne, a helium circulating system is employed within the gloveboxes, with internal gas pressure being controlled between —0.5 and —1.5 in. of water. It is most important to obtain a satisfactory seal on shafts passing through the glovebox walls, such as the extended pinion shafts and the screwdown adjustment shafts in the case of the mill shown in Figure 9.

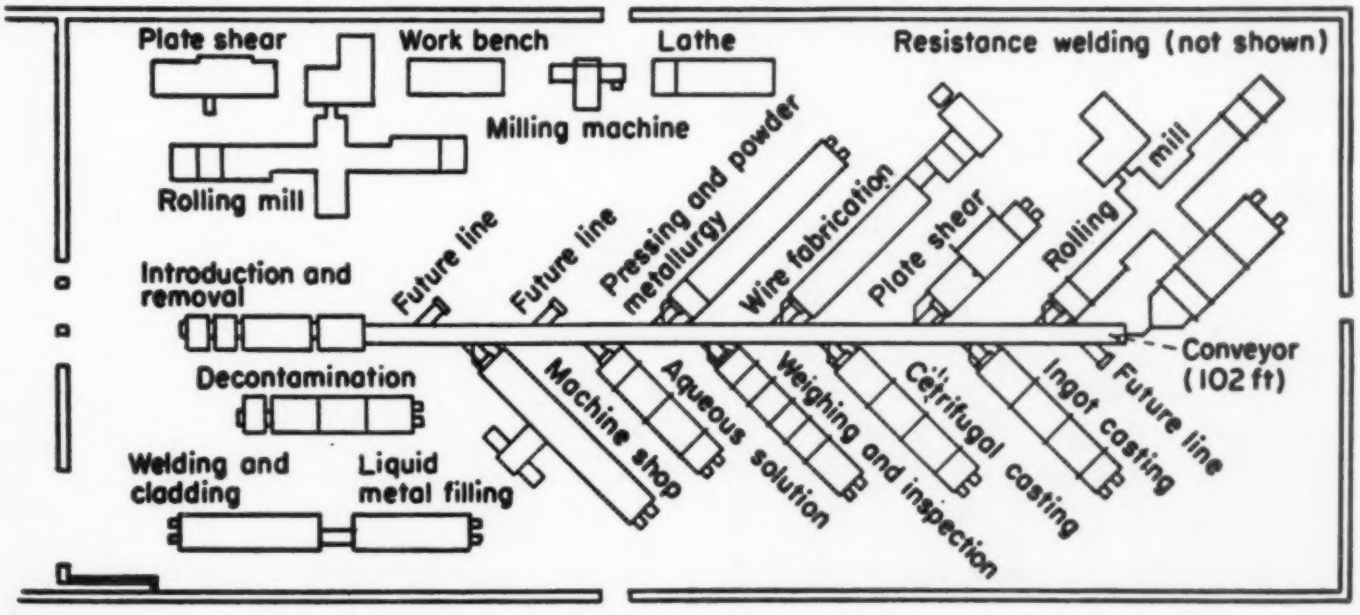
Standard O-ring gaskets have been found to make perfectly tight seals and are now in general use for glovebox applications. In accordance with normal vacuum technique, rotating shafts are carried through the glovebox wall by means of a substantial metallic flange which is O-ring gasketed to the wall. In turn, the shaft itself is passed through a commercially available cartridge seal mounted on the flange.

From a structural point of view, the glovebox containing the rolling mill comprises corner members extruded from 61S-T6 aluminum alloy, which shows excellent hardness and wear resistance. Figure 10 illustrates a representative longitudinal corner member used to clamp the glovebox structure to the machined ⅜-in. thick flange of the rolling mill base plate.

In view of the Argonne National Laboratory's special interest in fast breeder reactor power plants, its metallurgy division is particularly concerned with the processing of plutonium and its alloys. Plutonium fuel elements have already been used in the Argonne Experimental Breeder Reactor No. 1 and are providing important technical data on breeding and control behavior. The Experimental Breeder Reactor No. 2 which will be considerably more powerful with a heat output of 62,500 kw, is now being developed by Argonne and is scheduled to become critical at Arco, Idaho, in 1958. A facility for the development and the experimental fabrication of fuel elements containing plutonium is an essential requirement for the development of such fast breeder reactor power plants, and such a facility, comprising large-scale gloveboxes, is now under construction at Argonne. As indicated in Figure 11, the basic layout of this facility is in the form of a herringbone, with a central, enclosed conveyor system and integral branches eliminating the air transfer of materials between operations. Gas-tight valves separate the branch gloveboxes from the central conveyor. Every item entering the main glovebox system is assumed immediately to be contaminated beyond tolerance. Auxiliary equipment outside the primary gloveboxes, such as vacuum and hydraulic systems, mechanical drive assemblies and seals, which may be contaminated by gasket or joint failure, are also housed in protective hood enclosures.

Figure 12 shows one of the two principal rolling mills which are currently being installed in the above facility. Both these mills are reversible 2-high/4-high combination rolling mills with 2½-in. diam work rolls and 10-in. diam backup rolls. Each mill is driven by a 50-hp, d-c motor through an AGMA Class III extra heavy duty combination speed reducer and pinion stand and

Figure 11 — Layout of experimental plutonium fuel element fabrication facility at Argonne National Laboratory.



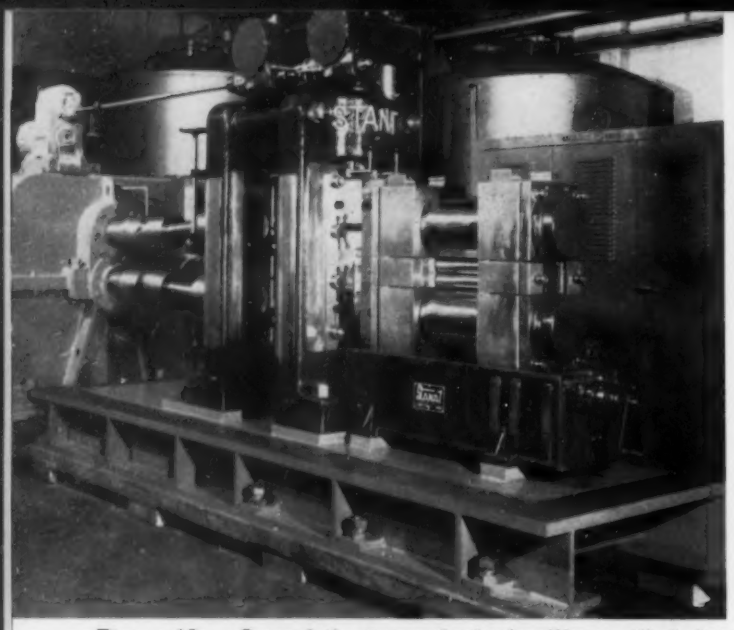


Figure 12 — One of the two principal rolling mills being installed at the Argonne National Laboratory.

has a 40 to 160 fpm constant horsepower range. A constant torque speed range from 5 to 40 fpm is also available. The mill has cage-type needle roller bearings on the roll necks and possesses a maximum separating force capacity of 600,000 lb at a rolling speed of 100 fpm. The power screwdown system of the mill comprises a 2-hp variable speed drive geared to furnish screwdown speeds of 0.15 to 0.60 in. per min.

Since the entire mill up to the pinion stand is enclosed in a glovebox system, special provisions had to be made to facilitate the feeding of work pieces and changing of rolls. Figure 13 shows the power-operated roll change mechanism which allows the entire roll assembly—either 2-high or 4-high—to be withdrawn from the mill housings. Once this has been accom-

Figure 13 — The roll changing mechanism is power operated.

Figure 14 — This 12-in. wide slitter is installed at Oak Ridge and uses 5½-in. diameter cutters.

plished, an overhead crane is available within the glovebox enclosure to change the roll assemblies as well as the individual rolls. The universal joint spindles of the mill are equipped with a special support to maintain their position while the roll assemblies are withdrawn from the mill. The machine is furnished with plain rolls for flat rolling and grooved rolls for the production of shapes.

SLITTING AND LEVELING

In addition to rolling mills, two other important items of metal processing machinery often required for the production of fuel elements and other reactor components are rotary gang slitters and roller levelers. Slitters are needed primarily for edge trimming purposes and are required to hold width tolerances as close as plus or minus 0.001 in. Figure 14 shows a 12-in. wide slitter installed at the Oak Ridge plant of the Union Carbide Nuclear Co. The machine has 2½-in. diam arbors and uses 5½-in. diam cutters. It is driven by a 3-hp motor and can handle sheet thicknesses to $\frac{3}{32}$-in.

Another machine installed at Oak Ridge is the roller leveler illustrated in Figure 15. This unit is intended particularly to handle aluminum and stainless steel-clad fuel elements in a 0.020 to 0.125 in. thickness range and in widths up to 12 in. The machine has nine 2-in. diam x 12½-in. wide leveling rolls and two 3-in. x 12½-in. wide exit pinch rolls. All rolls are positively driven through heat-treated alloy steel helical gearing and run in needle roller bearings. The leveler has a 3-hp, 40-fpm drive, with forward and reverse control. Screwdown adjustment is provided at the front and rear of the machine to control the degree of leveling applied to the fuel element sheets.

SEQUENCE OF FABRICATION

The design of a representative plate-type fuel element is illustrated in Figure 16. It was originally developed for the Materials Testing Reactor of the A. E. C., and 325 of these assemblies are currently being manufactured by Babcock & Wilcox at its Lynchburg plant. In this design, the fuel plates are curved and contain 13 per cent fissionable uranium 235 alloyed

Figure 15 — Fuel element sheets are straightened on a 12-in. wide roller leveler with nine 2-in. diameter leveling rolls.

with aluminum. The fabricating sequence involved in the production of such an element is indicated in Figure 17.

All fuel elements being produced at Lynchburg are clad with protective coating, usually of aluminum, zirconium, or stainless steel. This cladding prevents local "hot spots," corrosion, metal distortion due to irradiation instability, and the resulting escape of radioactive fission gases, and also confines the solid fission products to the "meat" of the fuel. Because a defective fuel element could contaminate an entire reactor core and force a costly shutdown, all manufacturing operations are based on extremely fine tolerances and intensive inspection. The high cost, strategic value, and potency of fuel element components also demands an accountability system which constantly shows the disposition and situation of materials down to 0.01 gram. A sequence of operations drawn up for the production of the Consolidated Edison reactor fuel element assemblies shown in Figure 18 illustrates the complexities of processing nuclear materials.

The Consolidated Edison reactor core is a right cylinder about 6 ft high and about 6 ft in mean diam. It is made up of more than 100 fuel elements as illustrated in Figure 18, containing alternate fuel and fertile or breeder plates separated by coolant channels. The fuel plates are 0.060 in. thick and are made up of highly enriched uranium-zircaloy-2 "meat" clad with zircaloy-2. (Note: The nominal composition of zircaloy-2 alloy is : 1.50 per cent tin, 0.12 per cent iron, 0.05 per cent nickel, 0.10 per cent chromium and balance zirconium.) The fertile plates are 0.080 in. thick and consist of thorium "meat" clad with zircaloy-2. The coolant channels are 0.100 in. wide.

Zirconium and enriched uranium metal for fuel plates are alloyed in a vacuum arc melting furnace, and subsequently the 100 lb, 4-in. diam ingot cast is re-melted into a 6-in. diam ingot to improve homogeneity. At this stage, the ingot is worth approximately $40,000. The vacuum arc furnace has an electrode-tower which houses the electrode on initial charging. During the re-melt operation, the tower is removed. Guide rolls, electric contact rolls and the electrode drive mechanism are housed in a bell section. A variable speed drive, which is actuated by power fluctuations during the melting, controls the drive mechanism. During start-up and shut-down, the operator can stabilize the arc by means of an over-ride mechanism. Sealed by gaskets into the bottom of the bell section is a water-cooled copper mold. This arrangement permits the circulation of cooling water at high velocity

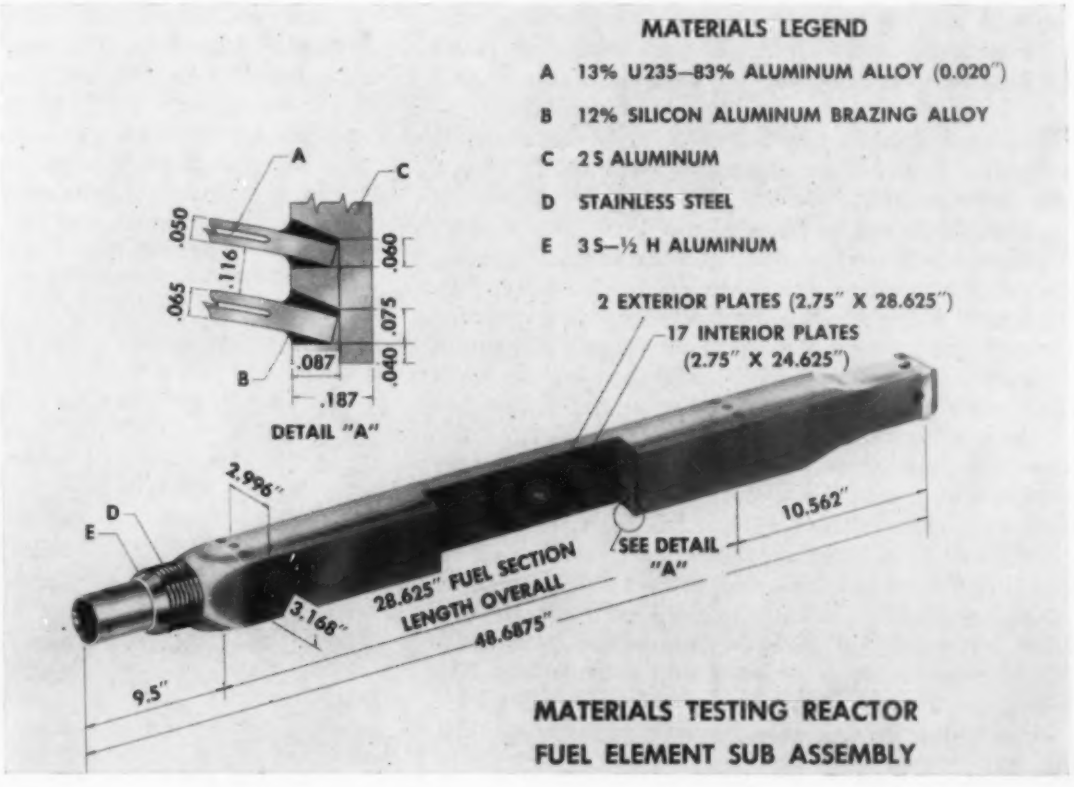


Figure 16 — Cutaway shows design of plate-type fuel element sub-assembly.

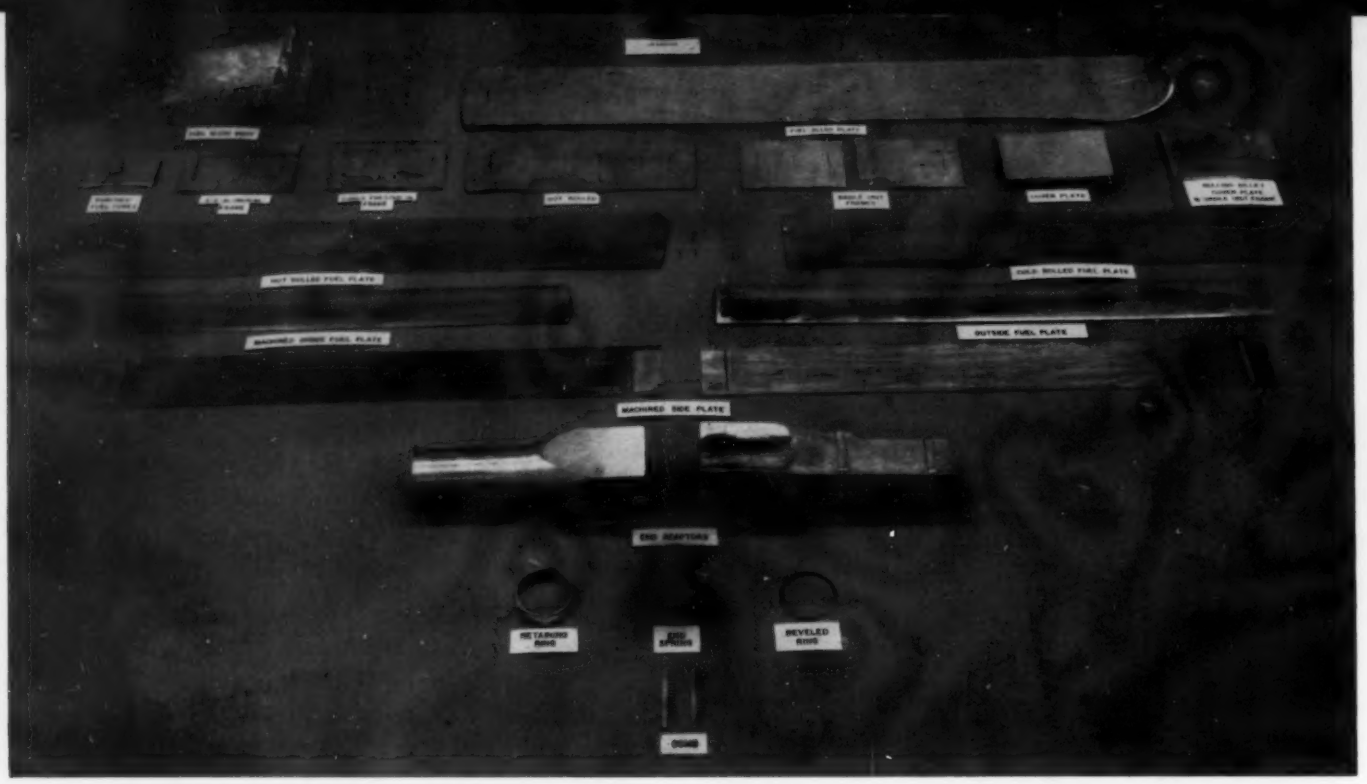


Figure 17 — Fabricating sequence involved in production of plate-type fuel elements for materials testing reactor are shown by the various component parts.

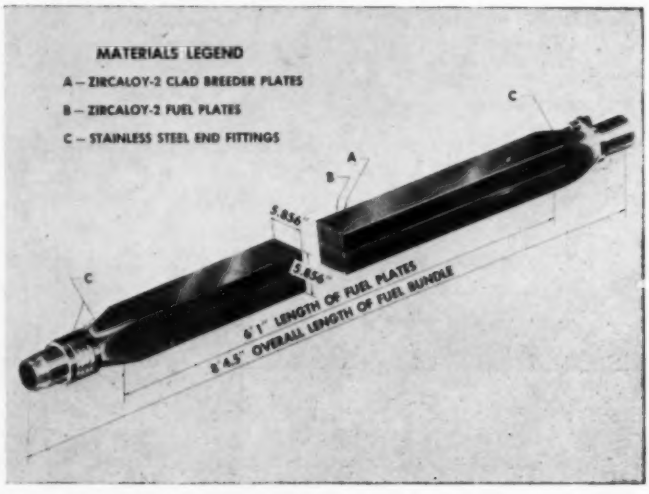
to solidify the ingot quickly. The bottom of the mold is insulated from the sides to insure that power flows from the electrode through the ingot into the bottom contact, thereby minimizing the possibility of arcing to the mold side walls. The furnace has a vacuum system of 100 cfm capacity, which is utilized for initial pumpdown. Normally operations are carried out in a helium-argon atmosphere, at a controlled pressure to obtain minimum glow discharge. Three 1450-amp welding rectifiers, which can be controlled individually, make up the power supply.

Next, the remelted ingot is conditioned on a 10-in. lathe to remove imperfect material and is then clad with a steel sheath. The clad ingot is then prepared for forging by heating to 1450 F in either a salt bath or a box furnace. The forging operation reduces the 6-in. diam ingot to a 1-in. thick slab and takes place on an impact type horizontal forging hammer. The hammer has a capacity of 6000 ft-lb per blow. It is air-operated, but can also be steam-powered. Work is positioned between the dies by means of a guide roller, and all the energy of the blow is imparted directly to the work. Each blow is controlled by the operator through the movement of a valve. Should it become necessary, the hammer may also be used with forming dies to facilitate small parts production.

The billet is reheated and is then hot rolled on the reversible 2-high/4-high combination rolling mill shown in Figure 19. To accommodate a variety of fuel element designs in the future, it has been arranged to obtain maximum flexibility of operation. Driven by two 50-hp, d-c motors, the mill utilizes 21½-in. diam x 22-in. face width rolls for 2-high hot rolling, and 6½ x 22-in. face width work rolls backed up by 21½-in. diam x 22-in. face width rolls for 4-high cold rolling. The rolling speed can be infinitely varied from 0 to 216 fpm, and the rolling direction can be reversed instantly. The mill has tapered roller bearings on the roll necks with pressurized lubrication. The maximum separating force capacity of the mill is 1,500,000 lb. The mill screwdown system consists of a dual arrangement with a de-clutching provision. The high-speed gear is driven by two 3-hp motors, and can be run at 4½ in. per min. The low-speed screwdown gear is powered by two 10-hp motors, and operates at 0.109 in. per min. In the roll drive arrangement, a double pinion stand permits driving either the backup rolls or the work rolls when operating the unit as a 4-high mill.

The second mill in the fuel element manufacturing area at Lynchburg is a reversible 2-high/4-high combination rolling mill which may be seen in the foreground of Figure 19. This machine, too, has been designed to offer great flexibility of operation and is proving particularly valuable in the finish rolling of fuel element and other reactor materials down to relatively thin gages of sheet, held to extremely close thickness tolerances. Driven by a 15-hp, a-c motor, the mill

Figure 18 — Precision is required if the fuel elements are to be assembled correctly.



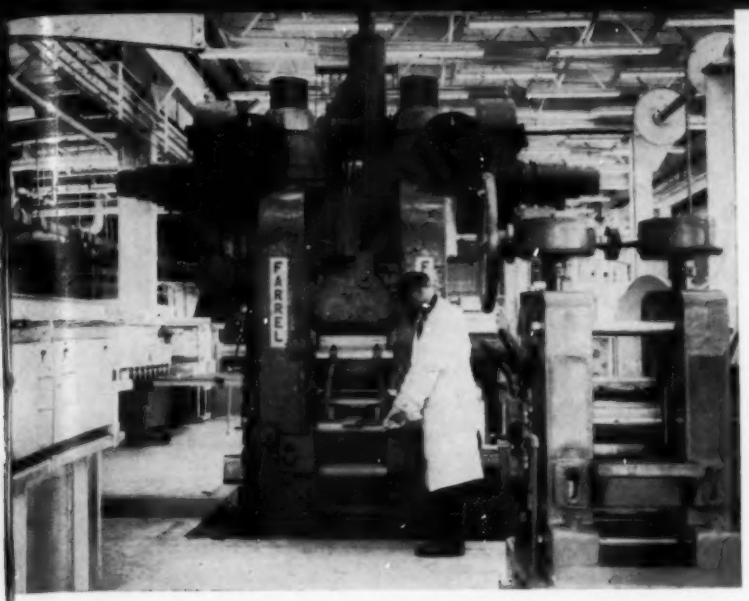


Figure 19 — This 6½ x 21½ in. x 22 in. 2-high/4-high combination rolling mill has a 100-hp, d-c drive.

utilizes 5-in. diam x 8-in. face width rolls for 2-high hot rolling, and 1½-in. diam x 8-in. face width work rolls backed up by 5-in. diam x 8-in. face width rolls for 4-high cold rolling. Speed control is obtained by a manual gear-shift system providing speeds of 30, 60, 110, and 185 fpm, and the rolling direction can be reversed instantly. The mill has cage-type needle roller bearings on the roll necks with pressurized oil lubrication. The maximum separating force capacity of the machine is 150,000 lb.

Once the billet has been hot rolled to the approximate fuel element core thickness, the steel sheath is removed and the plate is cleaned by vapor blasting and acid pickling and is cold rolled to punching thickness. Core size pieces are punched from the plate on a 160-ton press and assembled in a "picture frame" with zirconium alloy cladding. These assemblies are sheathed in steel once more, heated in an electric furnace to about 1450 F and hot rolled to the approximate finished fuel-plate thickness. The removal of the protective sheath takes place subsequently. The element is then cleaned by vapor blasting and acid pickling, and cold rolled to final thickness. Each plate is now examined in the laboratory fluoroscope to indicate the exact position of the "meat" and then machined to final width and length on a milling machine.

Thorium for the fertile plates is received in ingot form. The ingots are preheated in the salt bath furnace to 1400 F, and hot forged into billets for rolling. Reheating in the salt bath furnace to 1400 F follows, after which the billets are hot rolled to the approximate "meat" thickness. After cleaning by pickling, the strip is cold rolled, punched to the proper thickness and width, and assembled with zirconium alloy cladding. These assemblies are sheathed in steel, heated in the electric furnace to about 1400 F, and given moderate hot rolling passes. The assembly next is given a diffusion anneal in an electric furnace, followed by reheating and completion of hot rolling to the approximate finished plate thickness. The steel sheath is then removed, the plate cleaned by pickling, and cold rolled to the final thickness. This plate also is checked on the fluoroscope to indicate the "meat," before being machined to the final width and length.

Before assembly into a "bundle," the plates are acid-cleaned and rinsed in water. In bundling, 30 thorium plates and 38 uranium 235 plates are positioned in a jig and fusion welded. The welded assembly is moved to an electric furnace and given a diffusion anneal. This operation stress relieves as well as anneals. The assembly is then moved to a large milling machine, where it is machined to final dimensions. After machining, the assembly is placed on a large granite surface plate for inspection and the recording of dimensions. End nozzles are attached to the assembly by stainless steel rivets. The assembly is then moved to a 20-in. engine lathe for final and nozzle machining, after which it is given an acid cleaning and a water rinse. After final inspection, the bundle is identified on the outside by the engraving of a code number and then readied for shipment.

REPROCESSING OF SPENT FUEL

As the construction of nuclear power plants is proceeding, serious thought has to be given to the removal of depleted fuel elements out of the reactor vessel, the cooling to reduce radioactivity, the reprocessing of the spent fuel, the disposal of radioactive wastes and the reintroduction of the newly assembled fuel elements in the reactor. Unfortunately, nuclear reactors, unlike conventional boilers, do not "burn" all of the fuel inserted into them. Only a small part of each charge is consumed before the reactor must be reloaded—either because of radiation damage to the fuel element, accumulation of nuclear poisons, or because of the lack of enough fissionable material to maintain the chain reaction.

Spent fuel reprocessing involves extreme hazards due to the high levels of radiation involved. Accordingly, the major portion of such operations must be done within a shielded "cave" by remote control. This, in turn, calls for specially designed melting, casting, fabrication and assembly equipment, all capable of functioning under the "hot" conditions prevailing within this area.

Fuel elements may be reprocessed by either the application of aqueous chemistry or of metallurgical methods. The Argonne National Laboratory recently developed a pyrometallurgical method of reprocessing known as oxidative slagging. In this process, certain fission products are selectively converted to oxides and are accumulated in a slag layer. The method is designed to remove from irradiated uranium or uranium-plutonium alloys a significant part of the fission product elements, thus permitting the reuse of the metal as nuclear reactor fuel. Following oxidative slagging, the metal is put through the usual cycle of ingot casting to fuel element assembly, except that all necessary operations are performed by remote control within a shielded area. A remotely operated fuel element reprocessing facility of this type is currently being developed for the Detroit Fast Breeder Power Reactor by Atomic Power Development Associates, Inc. This shows an interest being taken by private enterprise in this field and indicates a future trend, when the A. E. C. will cease to be the only industrial source of reprocessing irradiated fuel elements.

CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

Friday, December 14, 1956

Christmas Dinner and Dance

Cocktail Hour 6:30 P.M.

Dinner 7:30 P.M.

Dancing 9:00-12:00 Midnight

Thomas Jefferson Hotel, Birmingham, Ala.

BUFFALO SECTION

Saturday, December 8, 1956

Christmas Dinner and Dance 7:30 P.M.

Hotel Statler, Buffalo, N. Y.

CHICAGO SECTION

Saturday, December 1, 1956

Christmas Dinner and Dance

Dinner 6:30 P.M.

Palmer House, Chicago, Ill.

CLEVELAND SECTION
AND
YOUNGSTOWN SECTION

Saturday, December 1, 1956

Christmas Party

Rainbow Room, Hotel Carter, Cleveland, Ohio

DETROIT SECTION

Friday, December 7, 1956

Christmas Dinner and Dance

Detroit Yacht Club, Belle Isle, Detroit, Mich.

LOS ANGELES SECTION

Friday, December 7, 1956

Christmas Party

Clock Country Club, Whittier, Calif.

PHILADELPHIA SECTION

Saturday, December 1, 1956 — Dinner 6:00 P.M., Meeting 7:00 P.M.

"High Temperature Refractories"

"Open Hearth Furnaces," by Keith D. Bartels, Superintendent Masonry, United States Steel Corp., Fairless Works, Fairless Hills, Pa.

"Reheat Furnaces," by Edward E. Callinan, Superintendent Masonry and Labor, Alan Wood Steel Co., Conshohocken, Pa.

"Soaking Pits," by E. R. Sullivan, Turn Foreman, Blooming Mill Department, Bethlehem Steel Co., Sparrows Point, Md.

Engineers' Club, 1317 Spruce Street, Philadelphia, Pa.

PITTSBURGH SECTION

Saturday, December 8, 1956

Dinner 8:00 P.M.

Christmas Dance 9:30 P.M.

Penn Sheraton Hotel, Pittsburgh, Pa.

ST. LOUIS SECTION

Wednesday, November 28, 1956

Tour: A. O. Smith Corp.,

Granite City, Ill.

Saturday, December 15, 1956

Annual Dinner and Dance

Mineral Springs Hotel, Alton, Ill.

SAN FRANCISCO SECTION

Saturday, December 8, 1956

Christmas Party

The Village, Columbus at Lombard Streets, San Francisco, Calif.

UTAH SECTION

Thursday, December 6, 1956

Christmas Party

Salt Lake City Country Club, Salt Lake City, Utah

. . . . in wire drawing, it is necessary to supply a lubricant whose function is to form a coating about the wire in the first pass . . . . speed and severity of drawing, material and desired product finish are factors influencing

Selection of a Lubricant for cold drawing

Part I

COARSE STEEL WIRE

By BRUCE W. SIEMON
Standard Industrial Compounds Co.
Chicago, Ill.

▲ IT has been said, and in the opinion of the author, without contradiction, that steel wire represents the most highly finished product of the steel makers art. It is made in many varieties to serve many purposes. A recent examination of a wire manufacturer's catalog listed over five hundred separate wire commodities. There are but two things in common with all five hundred items; each has been cold drawn, and each is expected to give perfect performance in the hands of the consumer.

Obviously from a list of over five hundred items there must be great differences in the chemical and physical properties as well as the physical appearance of such wires. To those not familiar with the wire drawing industry, its practices, and terminologies: the raw product for producing wire is a hot rolled rod, which, after a simple surface preparation, is pulled or drawn through a die of somewhat smaller cross sectional area. This operation is done without the application of heat, hence the name cold drawing. However, those who have happened to place their hand on a coil of wire that has just finished drawing on a high-speed, dry drawing machine, may think the process ill named. The rod, after its initial passage through the die, ceases to exist; it has become a wire.

In the manufacture of steel wire, it is the general practice to dry draw the coarser sizes, and to wet draw the finer sizes. There are exceptions to this, of course, but generally speaking, wire 20 gage (0.035 in.) will be drawn employing a dry lubricant and called coarse wire; while wire finer than 20 gage will be wet drawn and termed fine wire.

Because of the complex nature of the lubricant's function in drawing wire, it bears examination before attempting to select a satisfactory lubricant. The word "lubrication" itself is misleading, since it normally implies an oily film adhering to the two bearing surfaces, with the frictional forces being transferred to the interface of the two oily films. The bearing portion of a wire die is vastly different from the ordinary bearing. In the common bearing, pressures are of the magnitude of a few hundred to a few thousand psi. In the case of the wire die bearing are found pressures from one hundred thousand to four hundred thousand psi. Lubrication in the wire die bearing is further complicated by the fact that one of the surfaces is constantly moving away from the other.

The lubricant plays only a minor role in overcoming frictional forces, its principal function being that of forming a plastic tube or coating around the wire. This in turn prevents contact between the wire and the die. The coating is formed in the first draft and is thought to consist of various oxides and hydroxides of iron and calcium, together with the stearates of sodium, calcium, and aluminum.

Failure of the coating occurs either through stretching, becoming thinner with the elongation of the wire, or through its decomposition or breakdown because of excessive heat. With the failure of the coating, application of additional lubricant is of no consequence and

further drawing becomes impossible until a new coating is established.

As has been stated, there are well over five hundred wire commodities, many of them falling into the coarse wire category, the selection of the proper or best lubricant poses somewhat of a problem. This problem may best be approached by an examination of the factors influencing the selection of a lubricant.

These factors are:

1. Speed of drawing.
2. Severity of drawing.
3. Material being drawn.
4. Finish desired on product or end use.

The last is by far the most influential in ultimately determining which lubricant shall be used. A step by step examination of the foregoing factors shows that:

Speed of drawing is an important factor in the choice of a lubricant. For with an increase in speed comes an increase in heat, which in turn results in a breakdown or decomposition of the lubricant. Lubricants that are adequate at relatively low speeds become useless at somewhat higher speeds.

Severity of drawing, the second influencing factor, has a double pronged effect. The first being the reduction per draft, and the second, being the total or over-all reduction. The reduction per draft again influences the heat built up within the wire, and influences the choice of lubricant through the lubricant's ability or lack of ability to function at the existing temperatures. The over-all or total reduction exerts its influence on the selection of a lubricant not only through the heat factor, but through another new and different factor. This is the ability of the coating, formed by the lubricant, to stretch and elongate, without rupture, with the elongation of the wire.

Material being drawn exerts its influence on the choice of lubricant primarily through the heat factor. The high carbons and alloys generally being the greater producers of heat. However, within this category another factor reveals itself. This is the surface condition of the rod or wire. Surface condition reflects itself in the ability of the rod or wire to pick up and carry lubricant into the die in order that a plastic coat or tube might be formed. An extremely smooth and dense surface offering fewer keys for coating to attach itself, is more difficult to draw than a surface that is more porous and open.

The final factor to be considered in choosing a wire drawing lubricant, that of finish desired on product or end use, is perhaps the most influential of all, for it is quite possible to find lubricants that might satisfy the requirements of the first three factors and yet be totally unsatisfactory by virtue of producing a finish unsuited for the end use of the product.

The materials commonly used as wire drawing lubricants are: oils, greases, and soaps. The oils, mainly the mineral and fatty oils, do not form thick, ductile plastic drawing coatings on the wire. For this reason the use of oils as a drawing lubricant for coarse wire is confined primarily to relatively light single drafts, at comparatively slow speeds. The oils are most often employed where a bright finish is desired, or where ease of lubricant removal is important. An example of such a wire would be one that is to be subsequently electroplated. The use of oils is not widespread throughout the coarse wire industry primarily because of the difficulty of confining them to the die box and the resulting messiness.

The greases, by virtue of forming somewhat thicker drawing coats, enable drawing at greater and more severe reductions at somewhat higher speeds, than is the case with the oils. Again, as with the oils, the greases find their greatest application where a bright clean finish, or ease of removal is the prime requisite. The greases are relatively easy to confine to the die box, and find more general application than do the oils.

Chemical type extreme pressure additives, such as chlorinated and sulphurized compounds, may be employed in both the oils and the greases, with caution. Many of the high alloys, such as the stainless steels, are affected by the chlorinated compounds, particularly where the drawing lubricant is not removed prior to annealing. Intergranular attack results from the use of such compounds. The sulphurized compounds are not advised for use on wires ultimately destined for use in welding, such as a weld rod. The deposited metal is objectionably high in sulphur.

The soaps comprise the largest group of coarse wire lubricants. They are capable of forming heavier and more ductile drawing coatings, that will withstand severe drafts and high speeds, with resulting high temperatures. Soaps are formed by reacting alkalies with fatty acids. The soaps may be varied by changing either the type of alkali, type of fatty acid, or by adding a so-called filler material.

Within the alkalies the most commonly used are: sodium hydroxide, potassium hydroxide, calcium hydroxide, and to a lesser extent, aluminum hydroxide. The potassium soaps are of a pasty nature and find greater use in the wet drawing or fine wire field. The sodium soaps are of a hard nature, and find extensive use in the dry drawing field. The soda soaps are water soluble, and being of somewhat lower melting point than the calcium or aluminum soaps, are easier to remove from the finished wire. For these reasons, they are generally used where subsequent plating will be employed, or where drawing speeds are moderate and heat is not excessive.

The calcium and aluminum soaps (metallic soaps), are hard by nature, and highly water insoluble. They have higher melting points than the soda soaps and are used where reductions are severe, and speeds and heats are high. They are commonly used on wires where a coating remaining on the wire is desirable, for either protective or lubricating purposes.

By varying the type or types of fatty acids, a control of the melting point is established, with the hydrogenated fats producing those soaps with the higher melting points.

The so-called filler materials—lime chalk, mica, sulphur, etc., act as mechanical aids in forming the plastic drawing coat, and serve to physically keep the wire from fusing with the die.

Thus, by an understanding of the materials available as lubricants, and the factors influencing the choice of lubricants, it is possible to better select the lubricant most suited for the particular set of conditions imposed.

Part II

FINE STEEL WIRE

By W. B. BAUZENBERGER

Sales Manager

Apex Alkali Products Co.

Philadelphia, Pa.

▲ IT is hardly necessary to emphasize the importance of lubrication where friction and heat are involved and such is certainly the case in the cold drawing of fine steel wire.

The principal function of a fine wire lubricant is to reduce to a minimum the tremendous frictional heat generated in high speed drawing operations, as well as to lubricate the capstans or cones of the wire drawing machine itself. Most fine wire drawing equipment depends on slippage of the wire on the capstans to partially off-set the elongation of the wire in drawing. The lubricant, therefore, must not only reduce die wear, but must permit the wire to slip on the steel capstans without scratching or grooving.

Fine wire is generally referred to in the size range of 0.050 in. down to 0.003 in. and finer, and for the most part is drawn in wet solutions on cone type or ring block multiple die machines.

Speeds in this size range of wire can vary from 1000 fpm to as high as 5200 fpm, depending on the metal being drawn.

Fine wire is drawn wet in order to obtain special finishes and desired physicals: the finish being governed by the coating that is put on the wire prior to the drawing operation.

Large amounts of fine wire are consumed by such end products as insect screens, rope, brushes, paper clips and staples, each product requiring its own drawing practice, lubrication and preparation.

Lubricants alone are not wholly responsible for the successful drawing of fine wire, because it is highly imperative to properly prepare the wire in the cleaning house prior to the drawing operations. Acid cleaning must be carefully controlled, and a coating deposited on the wire to render it susceptible to lubrication.

The coating not only determines the final finish of the wire, but serves as a lubricant carrier, enabling the wire to carry the lubricant through the die, thus eliminating metal-to-metal contact.

Fine steel wire coatings can be a wide variety of chemical or mechanical deposits on the wire surface, such as copper flash platings, zinc iron phosphates, or lime.

Copper and liquor finish wire is drawn from wire that has been given a light copper sulphate dip, depositing on the surface a thin metallic film that will carry through the finish die on the wire. Liquor finish wire is produced in the same manner except that tin flakes or stannous sulphate is added to the copper sulphate bath to produce the straw color or silver finish.

Redrawn galvanized wire is produced in large quantities from either hot-dipped or electro-plated zinc stock, and is produced by passing wire strands through a molten zinc bath and wiped in powdered charcoal to produce smooth, bright surfaces.

The electro-plated wire is produced in a similar manner except that the wire strands are passed through an electrolytic zinc plating bath.

Both of the above mentioned wires can be most troublesome in drawing, because of the tendency of the soft coating to peeling. However, this condition can be corrected by adjusting the lubricant and die angles and/or bearing angles.

Fine wire drawing lubricants are divided into four classes and are recommended in accordance with type of wire, number of successive reductions given the wire, and the finish:

1. Straight soap lubricants.
2. Emulsion type or soap-fat combinations.
3. Petroleum oil or petroleum oil derivatives.
4. Water emulsifiable oils.

Each of the above mentioned lubricants has its specific place in the fine wire industry, and great caution must be exercised in the choice of a water miscible lubricant, as its stability can be affected by the local water conditions and/or contamination from the wire being drawn.

Straight soap lubricants usually consist of sodium or potassium soaps, and are recommended for drawing ferrous wire in the size range of 0.009 in. and finer. This type of lubricant must be used in very light concentrations, and for the most part, are easily contaminated by the carryover of plating solutions and lime. Control methods for checking concentration of straight soap lubricants are most difficult due to the small amounts of total fats available in a diluted solution.

Straight soap compounds have the advantage of being readily dispersable in water, and at the same time, keep the machine's interiors free of fat build-up and excessive sludging.

Emulsion type, or soap-fat combinations, are used extensively in the drawing of the coarser sizes of fine wire, and are recommended where higher reductions of area are being taken.

These types of compounds are composed of sodium or potassium soaps in combination with fats and free fatty acids. Saponified fats alone do not produce a stable emulsion, and therefore, the addition of fatty acid is required. This additional ingredient combines with the fatty matter and soap to produce a stable emulsion that will spread or wet out a hot metal surface. Additives are made to this type of lubricant to increase film strength, and to render the emulsion more tolerant to contamination while in use.

Various ratios of soap to fat are produced in this type of wire drawing lubricant and are generally recommended for use in either liquor finish or lime coated stock. High fat and low soap ratios are used in drawing ferrous wire in sizes of 0.050 in. down to 0.020 in., and high soap and low fat ratios on sizes from 0.020 in. and finer.

These lubricants are generally supplied in a heavy paste form and are mixed with additional water to produce a usable emulsion with a total fat content of from 1 to 2 per cent. Careful controls for pH and fat content should be maintained in order to obtain optimum results.

Petroleum oil and petroleum oil derivatives used in

the fine wire industry are in the form of straight petroleum oils, fortified with extreme pressure additives such as fatty oils, sulphur and chlorine. Viscosities of these oils range from as high as 3000 SSU to as light as 50 SSU at 100 F, depending on the wire being drawn.

Heavy viscosity oils are generally used in slow speed single and double hole drafting of heavy gage carbon and stainless steels, particularly where special oil finishes are desired.

Lighter viscosity oils are re-circulated in multiple die fine wire machines for drawing fine alloy and stainless uncoated wires. Most alloy wires used in the electronics industry must be finish drawn clean, and therefore, most of this wire is drawn free of lubricant carriers or coatings.

Fine stainless wire drawing requires thin film lubrication, such as that produced by light viscosity oils fortified with extreme pressure additives to withstand the great pressures created in cold drawing. These extreme pressure oils combine the cooling qualities of water and the anti-seizing effects of a solid film lubricant.

Water emulsified oils, commonly referred to as soluble oils, are a mixture of two or more insoluble liquids such as oil and water, rendered water miscible by an emulsifier.

Petroleum sulphonates, fatty acid soaps and synthetic emulsifiers derived from fats, are commonly found incorporated in the so-called soluble oils.

This type of lubrication is found in the fine wire industry in place of the conventional soap-fat combinations, and has proven quite satisfactory for certain types of wire drawing. It has excellent cooling properties, almost complete absence of foaming, ease of mixing, and will provide a rust resistant film on finished wire. These properties have tempted many to try this type of lubricant, but it has been found to be more costly, due to higher concentration requirements, and, in some cases insufficient lubrication.

One of the greatest challenges facing the wire drawing lubricant manufacturers today, is the job of keeping abreast of advances made by the wire drawing machinery manufacturers, as well as, the many newly developed alloys introduced by industry's metallurgists, and we are attempting to keep pace with these strides by increased research and development.

DISCUSSION

PRESENTED BY

JOSEPH SADOWSKI, Lubrication Supervisor, Crucible Steel Co., Syracuse, N. Y.

BRUCE W. SIEMON, Standard Industrial Compounds Co., Chicago, Ill.

W. B. BAUZENBERGER, Sales Manager, Apex Alkali Products Co., Philadelphia, Pa.

A. A. BRITTON, JR., Vice President, Carpenter Steel Co., Reading, Pa.

Joseph Sadowski: I have done some work with drawing lubricants, particularly in trying to evolve some lubricants for cold drawing titainum. On the basis of experience in cold drawing titanium, I would like to know basically what type of lubricant the authors found to be most successful, whether it is the liquid type, the paste, or the solid type?

Bruce W. Siemon: I would like to answer the question, but I do not know the answer. However, I believe you will find that both are employed, generally speaking. The coarser sizes, will use the dry lubricant, and the finer sizes will use the wet lubricant. Actually, I have had no experience in drawing titanium wire.

W. B. Bauzenberger: The only experience we have had as far as titanium is concerned is the drawing of fine wire, which has been done with a wet straight extreme pressure oil for the exceptionally fine sizes.

A. A. Britton, Jr.: What has the original preparation of the wire, such as the dipping after the cleaning, to do with the application of the lubricants in the die drawing machine or the die blocks? Is it important to have a good preliminary coating, whether it be lime or some other kind of a dip in borax, to follow through with the lubricant being used in the wire drawing operation?

W. B. Bauzenberger: I think the answer to that question is quite simple, in view of the fact that coatings or lubrication carriers (may we call them) are most important in any cold drawing operation.

Coatings are a variety of different types of materials, such as lime, borax, various alkaline combinations, and they all have their specific purpose, depending on the type of metal that is being drawn.

Carbon steels require a certain type of coating, whereas stainless requires another. Coatings, I believe, are almost a subject by themselves, because they are very influential in wire drawing, as they have to carry the lubricant to eliminate the die-to-metal contact.

A. A. Britton, Jr.: Do you tie in a certain type of coating with a certain type of lubricant, or can you use the same type of coating to carry all lubricants?

Bruce W. Siemon: The answer is no, you can not. The answer to the question of whether some coatings are compatible to certain types of soap, while others are not is definitely yes. The rich soda soaps, the soaps having higher lubricity, so to speak, are not generally compatible to borax; they are too rich.

I think I also heard you ask whether it is important to establish a good coating. Very definitely yes. Generally, the so-called lubrication failure is a coating failure, not a failure of lubricant at all. The wire is perfectly capable of being further drawn. It has not reached its ultimate strength. You have a breakdown in coating. You have to stop drawing and anneal generally. You generally anneal because a further establishment of coating would mean only one or two more drafts, and then you would reach the end of the metal's ability to be reduced.

So, a good coating is of the utmost importance. There are certain soaps—some of the metallic soaps—that are more compatible to the lime substitutes. With lime you can generally use either the metallic or the soda soaps with equal ability, depending, of course, on what speed you are drawing at, and a number of other factors, such as the die practice design.

By EUGENE H. SWETT, Fuel Engineer, Bethlehem Pacific Coast Steel Corp., South San Francisco, Calif.

Some Methods for Analyzing and Controlling an Open Hearth Operation

. . . . from statistical data, the effects of many important variables in open hearth operation can be analyzed . . . . as a result, controls can be set up which will maximize production and minimize off-quality heats . . .

▲ THE efficiency of an open hearth furnace operation may be measured in terms of production rate, ingot cost, and product quality. The betterment of these measuring standards is a constant challenge to open hearth operators. In general, an effort to increase the efficiency of a shop may be approached in two ways: first, improvement in size or efficiency of processing equipment through capital expenditure; and second, improvement to the existing operating practice without changing the basic equipment. This latter method is the one of primary interest here.

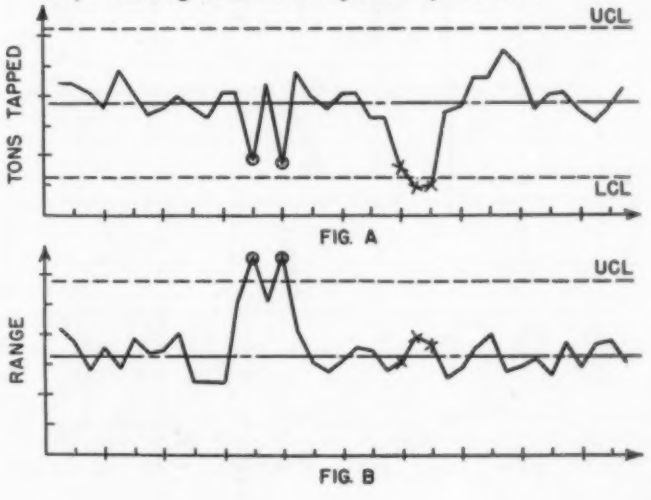
This paper will endeavor to present certain relatively simple and easily applied statistical methods to assist the operator in analyzing and controlling some of the many interrelated variables which affect an open hearth opcration. Utilizing examples, certain variables will be studied to illustrate their effect upon production rate or product quality, or to indicate the economic interpretation of these two factors. This approach is considered more immediately applicable to an operation than a technical or theoretical approach endeavoring to explain the variables involved.

The methods presented in this paper were developed in a cold metal shop consisting of five 75-ton basic furnaces, with an annual rated ingot capacity of 252,000 tons. Approximately 93 per cent of the ingot production is bottom cast. The normai product range consists of plain carbon steels with a carbon range of 0.05 to 0.95 per cent. About 50 per cent of the production is rimmed and 50 per cent killed or semi-killed steels.

The first step in controlling an operation is to find a method by which the operation can be easily observed and analyzed. Often it is assumed that an operation is satisfactory when an average is calculated for a selected period of time. However, this can be a very erroneous conclusion. Consider a location that advertises its wonderful climate and states that its yearly temperature averages 72 F. It can be seen quickly that this may be a place to avoid as it may be 32 F all winter and 112 F all summer. Exactly the same case may apply to open hearth operating variables such as charging density, tons tapped per heat, melt carbon, etc. A calculation of averages may therefore be of little value in controlling the operation. Rather, what is often required is some method which will indicate the dispersion of the data about the average value, illustrate the consistency of the operation on a day-to-day basis, point out trends or shifts in the observed variable, and indicate the presence of new causes of variation in the process.

Mean and range control charts, often referred to as bar X ($\overline{X}$) and R charts, offer one method of presenting data so that this information may be obtained. The derivation of this control method will not be discussed here as that information can be found in any production control handbook. What will be shown is how these two graphs can be of value in analyzing an operation. For illustration, the tonnage tapped per heat will be used. Each point on Figure 1A, the mean or averages chart, is the average tonnage of five successive heats. Each point on Figure 1B, the range chart, represents the greatest difference in tonnage tapped within the group of five heats. On the averages chart control limit but when noting the corresponding points and (LCL) lower control limit, while on the range chart only an (UCL) upper control limit is drawn. The control limits are calculated from past data and include approximately 99.7 per cent of the chance

Figure 1 — Mean and range control charts are one method of presenting data for analysis of operations.



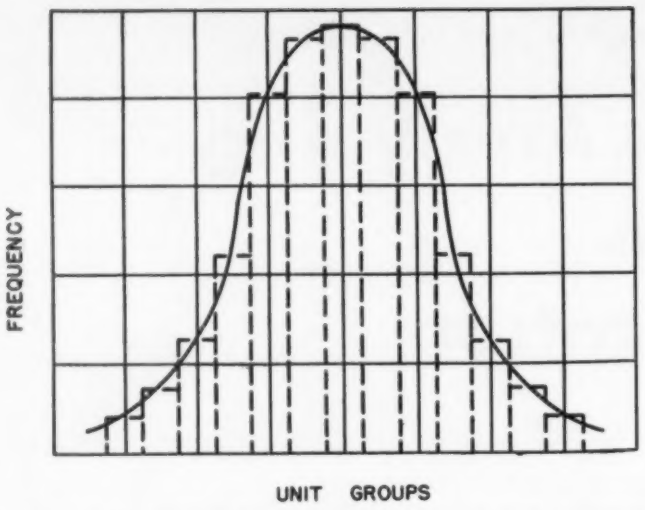


Figure 2 — Normal frequency distribution is illustrated by this chart.

variations within the system from which they were derived. Whenever the data plots outside of these limits, it is an indication that some new assignable cause of variation has occurred and that the operation has become "out of control." This does not imply that the operation was necessarily an efficient one when the control limits were first calculated, but rather that some additional factor is now affecting the operation. In addition, runs of points above or below the average may also be interpreted to indicate a shift in the process.

As an example of how this control would function, consider the crossed points on the mean chart. These points are closely approaching the control limit. If, when this data occurred, an effort were made to find the cause of such low tonnage, a remedy could have possibly been found and the following points would have been higher with a resultant increase in production. When observing the related points on the range chart (crossed) it can be seen that they plot near the average range or above, thereby indicating that all the heats in the group were affected in the same manner. In this particular case, a zero shift in the scrapyard scale weights was found to be the source of trouble.

The circled points on the mean chart approach the control limit but when noting the corresponding points on the range chart, it can be seen that there was one small heat in each group that made what would have been a normal average range, extremely high. Two such occurrences in such a short time prompted an investigation which revealed the source of trouble. In these instances the smaller volume of one ladle, caused by the repeated addition of slurry without the proper cleaning procedure, resulted in the reduced tonnage since steel was lost over the top of the ladle when the heat was tapped. As a result, heat size was misjudged and the teeming of the last bottom pour group rendered ingots too short for rolling. It will be found that during each campaign when the operation is plotted and remedies apportioned when necessary, the control limits will converge and the overall operation will be much improved.

Many operators may feel that they have no need for such an aid since they are always familiar with the daily production rate and problems. However, by utilizing a control chart such as this, with similar charts on delays, chemical analysis, charging practice, etc., an analysis of trends and an overall view of the process, which might be overlooked, can be quickly obtained.

An analytical method of great value to the operator is the curve of frequency distribution. In this instance the data under study is arranged according to the frequency of occurrence of the individual items. The total range of the items values is divided into groups which are plotted on the abscissa. The frequency, or number of items in a group, is plotted on the ordinate. Figure 2 illustrates a normal frequency distribution. Often extraneous variations or additional systems are contained in the data being studied, which will yield a distribution that is considerably skewed from the normal curve.

An interesting application of this method was found when investigating some effects of melt carbon. By plotting the melt carbon of heats for two campaigns, Figure 3 was obtained. The average value of this data was considered good, but when observing the plot it can be seen that the melt carbon was far from being a normal distribution. Reviewing the data it was found

Figure 3 — Deviation from normal frequency distribution pointed out that something was wrong.

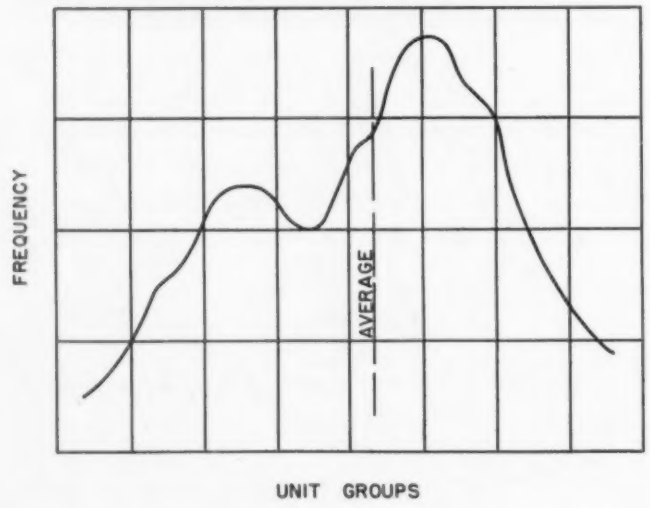
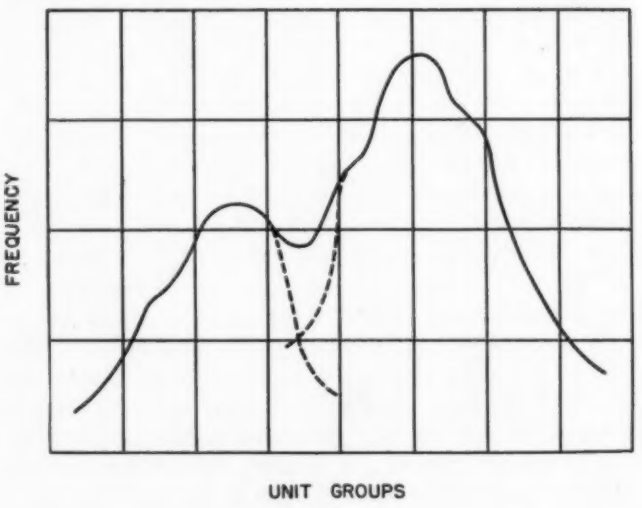


Figure 4 — Deviations may be due to more than one cause.



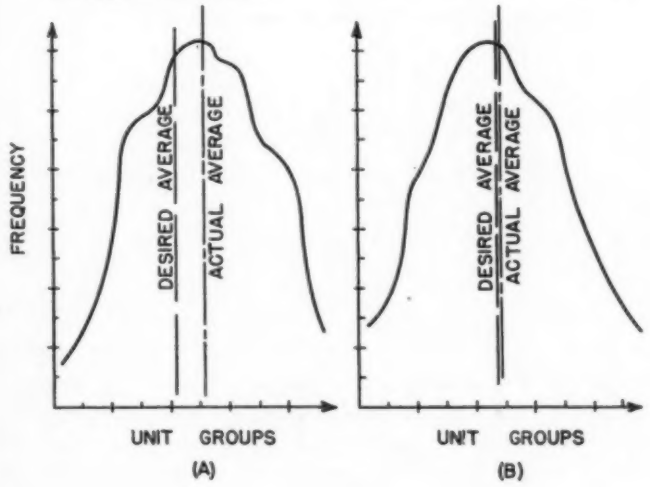
that there was one grade of steel being produced that always had low melt carbons. Figure 4 shows that there were actually two separate distributions within the system. Illustrating this fact to the production personnel prompted them to make the necessary corrections, thereby increasing the production by improving the melt carbon of the one group.

When the operation had been corrected, the average melt carbon became somewhat lighter, as shown on Figure 5A. During the following period of adjustment the distribution was followed closely to minimize the number of high and low values until the desired average value and dispersion were obtained, as shown in Figure 5B.

A second measure of the distribution, or spread, of operating data is the standard deviation. This value is simply the square root of the sum of the squares of the individual items, divided by the number of items minus one. Graphically, the standard deviation is observed by referring to Figure 6 which again illustrates the normal curve. Some 68.26 per cent of the data of a normal distribution is contained within ± 1 standard deviation of the average value. Some 95.46 per cent of the data is within ± 2 standard deviations and 99.73 per cent within ± 3 standard deviations. Hence, for a normal, or close to normal distribution, the standard deviation presents information regarding the dispersion of data as does the frequency distribution. If the distribution is not normal, or is unknown, the standard deviation still provides a useful index of data dispersion. Future developments in electronic data processing may well make it simple as well as advantageous to add this figure to certain operating data which is now supplied to shop operators on an average monthly basis.

It is now desirable to refer again to the control chart of Figure 1 and to further amplify on the significance of the control limits shown thereon. It can be shown statistically that when the data under consideration does not form a normal frequency distribution, as is quite often the case, a plotting of the averages of sub-groups within the system will provide a close to normal curve. Hence, when sub-groups are considered, as in the case of range and mean control charts, a normal frequency distribution may be expected. The significance of the control limits, then, is that they represent three standard deviations from the mean. The probability of a point plotting outside these limits as a result of pure chance will usually be found to be less than 3 in 1000. Therefore, such an out of limits occurrence can usually be attributed to some new factor affecting the system.

Figure 5 — Adjustments are made until the desired average is obtained.



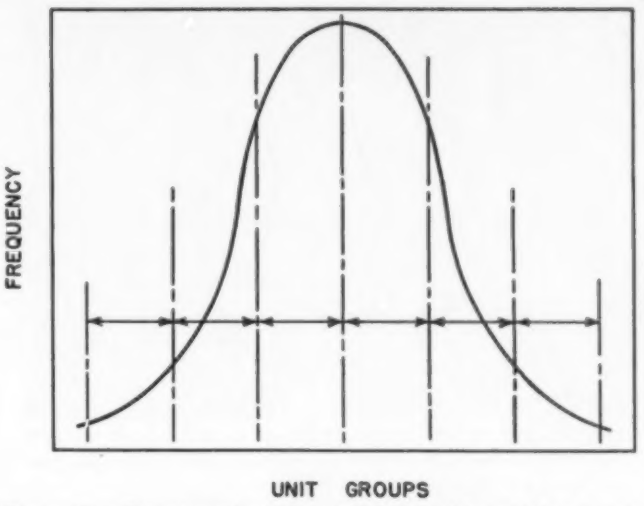


Figure 6 — Standard deviation is obtained from the normal distribution curves.

When a given open hearth operation is to be analyzed, it is advantageous to know the basic relationship between some of the many variables in a specific shop. It is possible to construct a graphic relationship between many of the variables. The relationship may be expressed as a straight or curved line which is a definite mathematical function. An illustration of this method is shown on Figure 7 which is a plot of total CaO charged vs. melt sulphur for individual heats. This data was obtained from heat records for two furnace campaigns. Before plotting, a frequency distribution was made which showed that there were two separate systems in one, as illustrated when discussing melt carbon. This type of distribution was caused by two distinct grades of charges, as related to quality. It was, therefore, necessary to plot a relationship between CaO charged and melt sulphur for each group. Figure 7 is

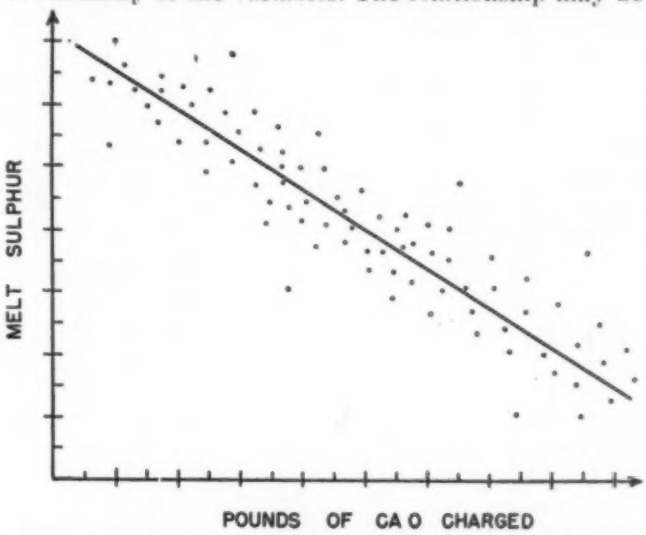


Figure 7 — Knowledge of basic relationships between variables is desirable in analyzing charts.

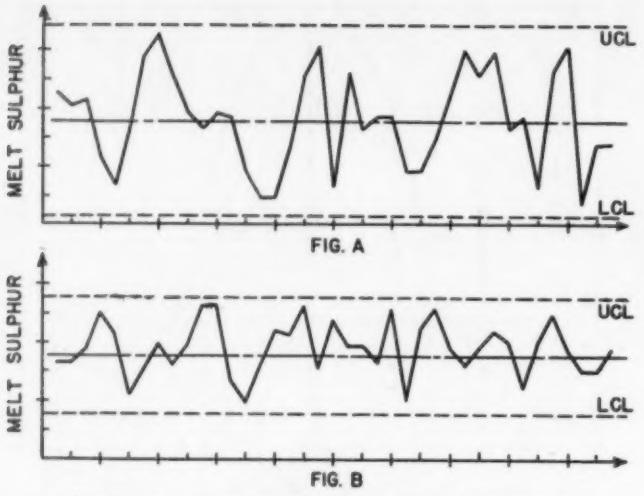


Figure 8 — Curves show typical control charts.

a plot of one of these groups. Finding the mathematical function that best represents this relationship now makes it possible to calculate the minimum amount of lime and limestone (CaO) to charge, to obtain a desired melt sulphur in this particular shop.

As a result of this investigation a concerted effort was made to standardize and reduce the flux burden without impairing the product quality or increasing the heat time by requiring extra lime additions during the working period. Standard charges of lime and limestone were developed for each grade produced. Figure 8 illustrates typical control charts showing the effect of this control program on melt sulphur. The final results yielded a 20 per cent reduction of flux burden while appreciably decreasing the working time of the heat.

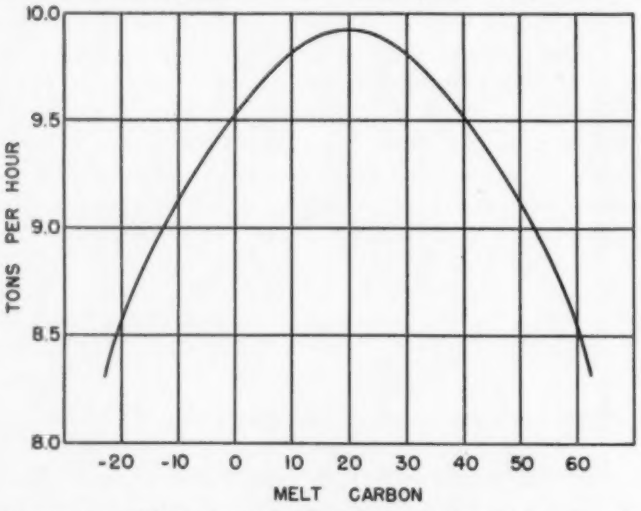


Figure 9 — Maximum production as a function of melt carbon is shown to be at 0.21 per cent above the product specification.

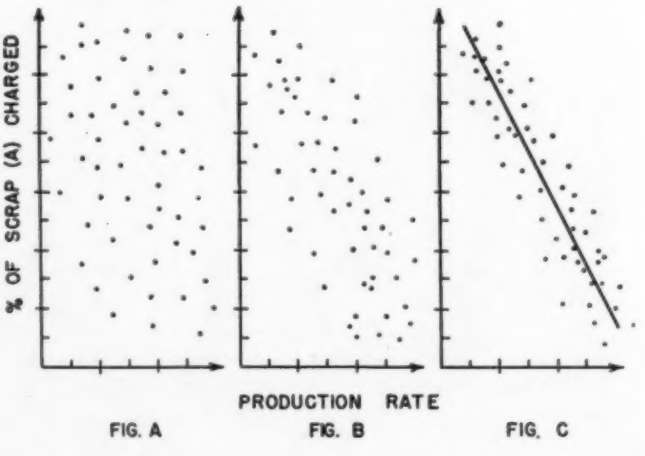
As another example, consider a plot of melt carbon vs some production rate unit, such as tons per hour produced. Figure 9 illustrates this relationship. It should be noted that the term "melt carbon" in this case means the difference between the carbon specification of the grade made and the first carbon analysis taken while the heat is working.

As would be expected, the data plots in parabolic fashion and can be represented by a mathematical function. The vertex of the parabola is 21, which means that the most favorable melt carbon as far as the production rate in this shop is concerned is 0.21 per cent above the product specification. The plot illustrates that while carbon diverges at a constant rate, the decrease in production increases at an increasing rate. Therefore, while only 0.1 tons per hour are lost for a melt carbon that is 10 points away from the optimum, 0.4 is lost for a melt carbon that is 20 points from the optimum.

As previously mentioned, the data that is required for such analyses has been obtained from records of previous furnace operations. If the data is taken from these records without any consideration given to the operation, a plot of one variable as to another will be derived similar to that of Figure 10A. With such an arrangement, there is absolutely no correlation between the two items. This apparent lack of correlation is caused by the other variables that are inherent to the operation. It is, therefore, necessary to account for the major variables and eliminate their effect.

Since the first operation in an open hearth shop is charging, it is well to begin an analysis at this point. If the data is carefully selected so that heats having delays due to charging, adverse melt carbon and melt sulphur, etc., are eliminated, a representative relationship can be derived between the charging practice and some unit of production rate. Once the mathematical relationship is established between a unit of production rate (tons per hour) and a unit of charging practice (weight per car, charging time, or number of cars), a correction factor can be calculated and applied to all the heats to eliminate the variance due to charging. The analysis can then proceed to another item such as melt carbon, and the heats that were eliminated previously due to adverse melt carbon can then be included and their effects evaluated. This method can be continued for any number of variables for which a relationship with the production rate is desired. Figure 10 illustrates the preceding method of gathering data. Figure 10A is a plot of per cent addition of a type of scrap (A) vs. tons per hour, without regard to delays occurring through the operational variables. Figure 10B shows the same data after it has been corrected for the influence of weight per car charged. Figure 10C shows the data after it has been corrected

Figure 10 — A breakdown of data into various variables may develop good degrees of correlation.



for the influence of weight per car charged plus the variation due to melt carbon. It can be seen now that a high degree of correlation exists between the per cent of scrap (A) added and the production rate, that before was not evident.

Systems such as just illustrated can be formulated for other operational variables. A knowledge of the effects of various items on the furnace production rate will lend a better understanding of the operation to the interested observer.

When operating an open hearth shop, it is often desirable to conduct experiments to determine the effect obtained by changing items such as fuel, raw materials, etc. Depending upon the particular case, the test period may have a duration of one heat or several campaigns. Since the effect of any new variation may be small, and the test duration limited for economical reasons, it is vital that the operator closely control the testing procedure to obtain the most significant results possible.

The prime requirement for obtaining significant test results is the establishment of a standard with which the test data may be compared and evaluated. Whatever this standard may be, the operating conditions must be maintained as constant as possible during both standard and comparison groups. It should be noted that, in this type of investigation, a most important factor is the human element. The extra attention a furnace receives during tests requiring the presence of supervisory or extra operating personnel will often, in itself, result in increased performance. It is essential then that equal effort be expended on both standard and test heats.

One satisfactory method of conducting experimental trials is to rotate the test and comparison heats, either singly or in groups. Single rotation is applicable only if there is a negligible carryover effect (such as a change in checker temperature level due to varied treatments) from one heat to another. After a relatively short number of test heats or groups, often as low as 5 to 10 statistical methods may be employed to determine the level of confidence or significance of the obtained results.

For investigations involving different treatments or test levels, such as various percentages of an additive to the fuel, random sampling systems can be designed to speed the results and assist in eliminating or minimizing some of the extraneous variables. Again, statistical methods may be employed to determine the limits of reliability of the data. In any test procedure, correction factors for melt carbon, charging density, etc., may be applied to the operating data to yield a quicker and more accurate conclusion.

It should be noted that these same methods can be applied to obtain a formulation between the variables and the operating costs, which can be described as "break-even" systems. Initially, when preparing such an analysis, it is necessary to derive a value of "cost above," or conversion cost, as related to some unit of production. Although it may not always be possible to obtain a precise relationship between cost per ton and tons per hour, a close approximation can usually be secured. Preparing a break-even system will, in spite of the many extraneous variables, present a better

Figure 11 — Data on blackboard helps supervisors in understanding the overall operation.

perspective of the operation than would otherwise be possible, had the attempt not been made.

When considering the use of statistics to analyze and control an operation, the wealth of information contained in the accounting department cost sheets cannot be overlooked. Quite often the effectiveness of this information can be greatly increased by the simple expedient of plotting certain key monthly figures on a chart or graph covering a three year period or more. In this manner, long range trends may be observed. In addition, presentation of specific data to interested parties is often clarified and simplified.

Figure 11 is a picture of a blackboard mounted in the melters' office of the plant under discussion. The data presented thereon is intended to assist the melters and other supervisory personnel in maintaining a perspective view of the operation, and to illustrate their production progress. A second method of providing supervisory personnel with a long range view of the furnace operations is through the quite simple graphical representation of individual furnace production rates throughout a campaign, rather than on a monthly basis. In this way, a current furnace operation may be easily compared with past performance at specific stages of the campaign.

The most significant results of an analysis such as has been presented here are:

1. The effects of some of the more important variables can be analyzed so that a more exacting picture of the operation can be obtained and a control affected.
2. Such methods can be utilized to determine the optimum economic charging density, flux burden, melt carbon, etc., for a specific shop.
3. These methods can also be employed to yield more significant results from miscellaneous tests and operating experiments.
4. A system of control charts for various factors such as charge density, melt carbon, furnace maintenance delays, and production rate, to mention just a few, will present not only a summary of existing conditions, but a reliable indication of what will occur in the future.

It is felt that an accumulation of such benefits as described would have a significant value to all open hearth operators striving towards the goal of increased production and decreased costs.

RECTIFIERS

By R. J. MORAN
Steel Mill Engineering
and
A. SCHMIDT, JR.
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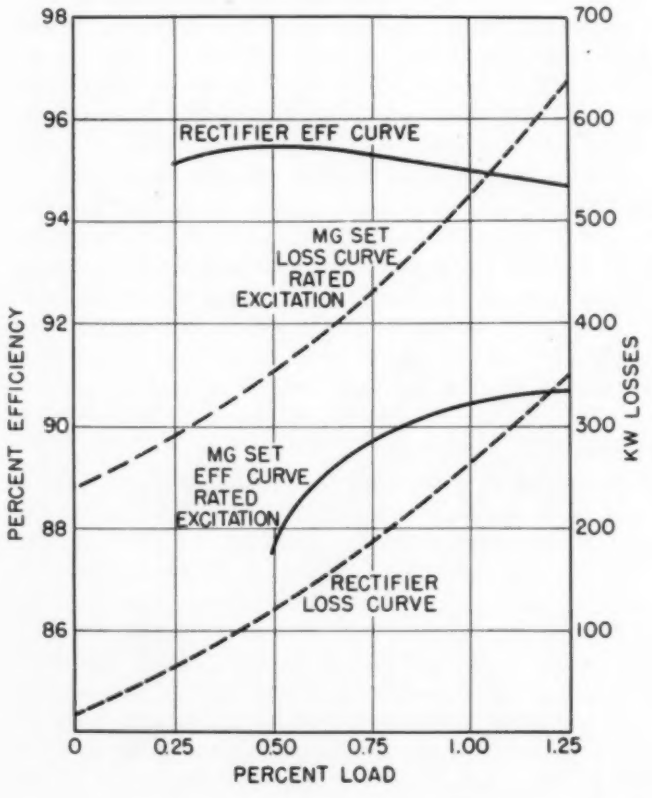
▲ THE steel industry is one of the large users of power rectifiers. Each steel mill application has its own special requirements, whether it be mercury arc rectifiers for a main roll drive, or semi-conductor rectifiers for a plating application. It is important today to have a working knowledge of all types of rectifiers in order to apply them properly and efficiently in steel mill use.

MERCURY ARC RECTIFIERS

The important characteristics, advantages and disadvantages of mercury-arc rectifiers which should be considered in their application are as follows:

1. Unregulated rectifiers have a drooping voltage characteristic of approximately seven per cent and the d-c voltage varies directly with the a-c system voltage. Therefore, all rectifiers for steel mill applications are furnished with voltage regulators to maintain accurate d-c voltage regardless of a-c voltage swings or changes in d-c load. Since the d-c voltage is directly proportional to the secondary voltage of the rectifier transformer, it is also important to select the transformer secondary voltage high enough so that rated voltage can be maintained for all required load conditions when the a-c system voltage is at its lowest level. Thus, it is important to know the characteristics of the a-c system before the rectifier transformer is designed.
2. The power and reactive peaks associated with rectifier operation are reflected directly into the a-c system. This can cause a-c voltage variations, the magnitude of which depends primarily on the size of the rectifier installation with respect to the power system.
3. Rectifiers do not contribute fault currents to short circuits on the a-c system. When synchronous motor-generator sets are used on a hot strip finishing mill for example, the fault contribution from the power source must be limited to roughly seventy per cent or less of the circuit breaker interrupting rating because of the fault contribution from the synchronous motors. If rectifiers are used, the a-c system can be designed with less reactance and improved regulation.
4. Rectifiers act as sources of harmonic voltages and currents which can cause telephone interference depending on the degree of exposure between communication lines and power lines, the type of installation and degree of shielding of the communication lines, and the magnitude of the rectifier load with respect to the power system capacity. If communication interference does occur, some of the remedial measures are multi-phasing of the rectifier installation, a-c filters, power line transposition, relocation and/or shielding of the telephone circuits.
5. The losses in mercury arc rectifier equipment are substantially less than the losses in rotating equipment. For the 5000-kw, 600-volt rating shown in Figure 1, the difference in losses results in an annual power cost savings of approximately $17,000 based on 7000 hours of full load operation with a power cost of one per cent per kwhr.
6. Arc voltage drop, which is the major portion of the rectifier losses, is practically constant and independent of voltage and current level. Therefore, the efficiency of the rectifier equipment is largely determined by the operating voltage as shown in Figure 2.
7. Rectifiers operate with a lagging power factor which is generally no better than 0.94 and which normally will be less than that, depending upon

Figure 1 — Comparison is made of efficiencies and losses of a rectifier and motor generator set when each is rated 5000 kw, 600 volts, d-c.



FOR THE STEEL INDUSTRY

Mercury arc rectifiers are an accepted practice for 250-volt constant potential service in steel mills . . . . they are particularly suitable for non-reversing mills which are infrequently started and stopped . . . . metallic rectifier application in the steel industry will be primarily in the field of adjustable voltage applications under 125 volts.

the amount of phase control required to regulate d-c voltage. Operation below rated voltage by phase control reduces the power factor in direct proportion with the voltage reduction. See Figure 3 for a comparison of motor-generator set and rectifier power factor.

8. Rectifiers are rated 200 per cent load for one minute occasionally repeated, the same as generators, and should be applied on that basis. However they are capable of carrying very high momentary loads for short times, on an emergency basis, as shown in Figure 4, and can ride through d-c short circuits without damage when protected by standard semi-high speed d-c switchgear.
9. The first cost of rectifier equipment is usually less than for motor-generator sets. Factors which can affect this price advantage are the kw-rating, voltage level, voltage range required and the method of obtaining the voltage range.
10. The rectifier is a static device and does not require heavy foundations capable of withstanding vibra-

Figure 2 — Mercury arc rectifiers are more efficient at the higher d-c voltages.

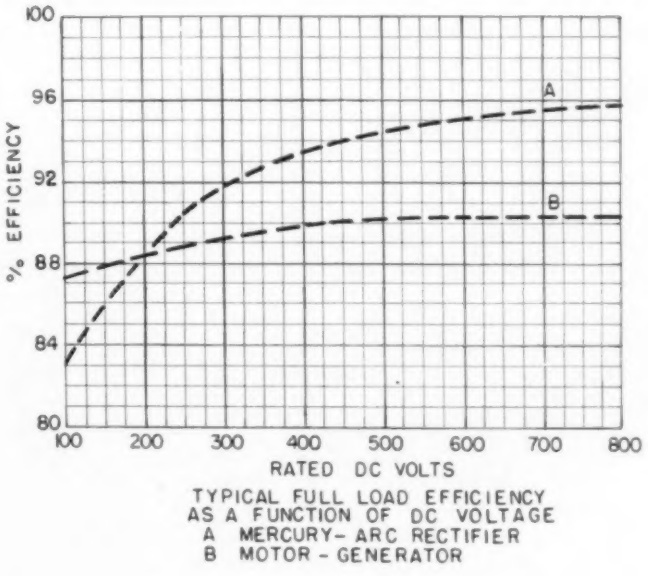
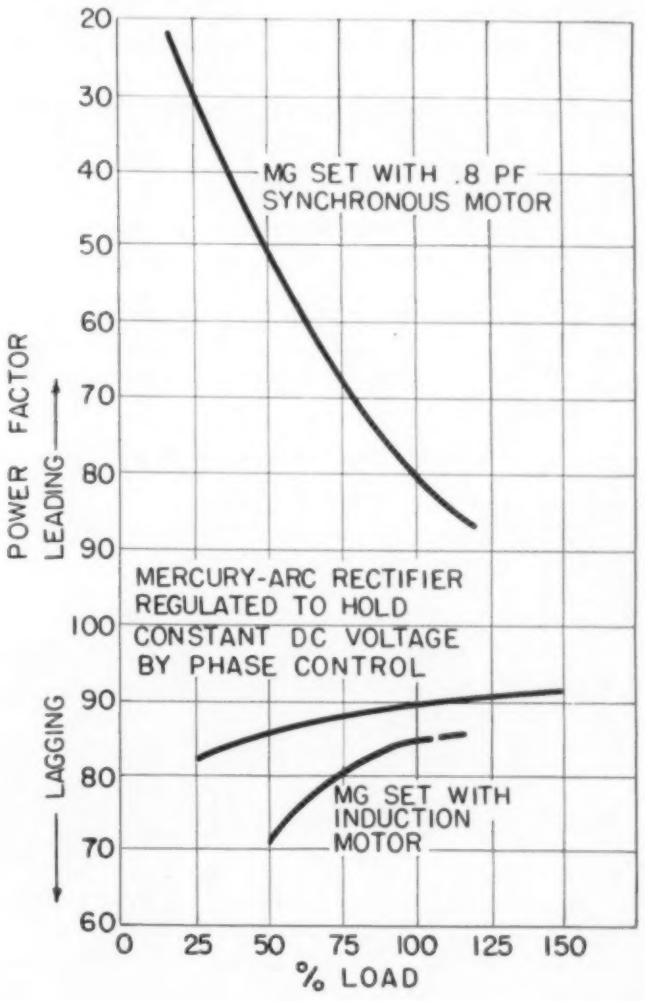


Figure 3 — Curves give typical power factors for d-c conversion equipment.



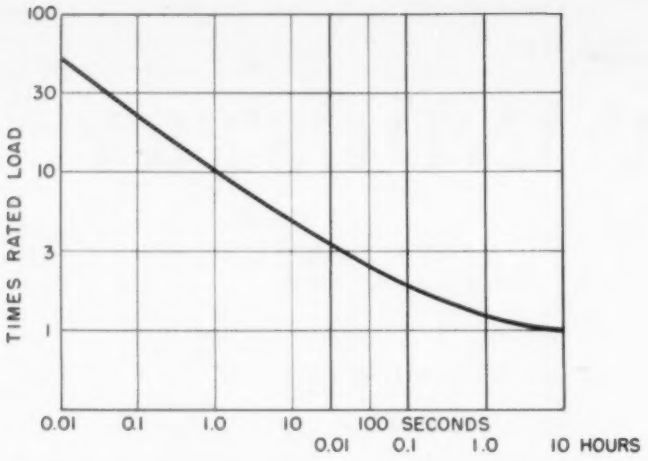


Figure 4 — Momentary overload characteristics of the mercury arc rectifier.

tions which are a major portion of the cost of installing rotating equipment. If floor space is limited, the rectifiers can even be installed on balconies. Figure 5 shows an artist's conception of a rectifier unit substation which would require the least amount of installation time because all of the main bus interconnections between units are factory prepared and can be easily bolted in place at the installation site. Equipments can also be supplied in separate sections if required by the layout of an individual plant. For example, the a-c switchgear can be located in the main plant line-up, the rectifier transformer located outdoors and bus or cable connected to the pumpless rectifier and d-c switchgear indoors.

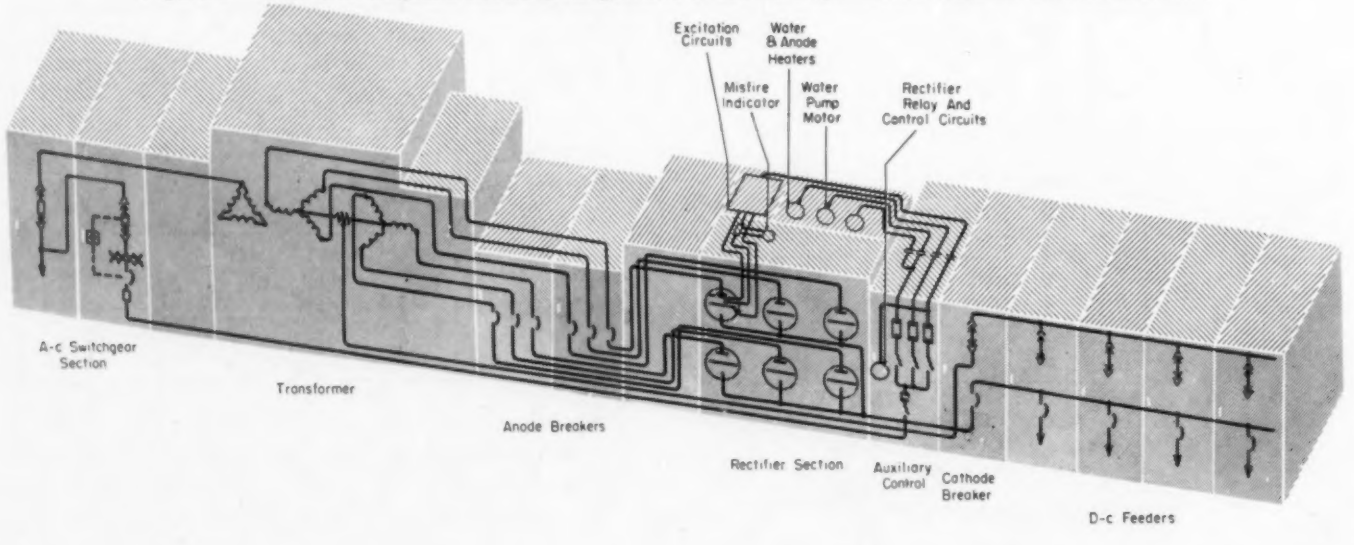
11. Ventilating equipment can be much simpler to install at a rectifier installation since most of the rectifier losses are carried off in cooling water which can be re-used in the plant water system. Ductwork, carbon dust filters and blowers required for motor-generator set ventilation are eliminated.
12. The maintenance cost of rectifier equipment is substantially less than the maintenance cost of rotating equipment as reported by users in previous articles.
13. Rectifiers are subject to arc-backs which are unpredictable and which can shut down the equipment without warning unless anode breakers are provided. These breakers have poles which trip independently on reverse current so that when an arc-back occurs only one pole opens. The other poles remain closed and keep the rectifier in operation. After a few seconds the pole which opened is automatically reclosed and the rectifier equipment is restored to full capacity.
14. Rectifier regulating systems have fast response and are accurate. With the current trend to split bus sections for rod mills and individual stand power supplies for hot strip mills, it is imperative to have an accurate regulating system with fast response to insure speed match between sections or stands.
15. A rectifier is a uni-directional device and is best suited for applications which do not require a reversal of power flow. Special switching and control are required to permit the rectifier to operate as an inverter for controlled regeneration back into the a-c system.

    An alternate method of providing uncontrolled regeneration is to connect resistors across the rectifier bus. This method is used with standard 250-volt shop power rectifiers to prevent over-voltage when loads capable of regeneration, such as cranes, are pumping into the d-c system. Automatically controlled resistors are also used with main roll drive rectifiers to prevent bus over-voltage and to assist in reducing speed when the mill speed level is changed.

A review of the above characteristics indicates that there are three criteria which should be considered before making a decision betwen rectifiers and motor-generator sets. The advantages of one over the other can be evaluated using the following three step analysis:

1. *Original investment*—This should include both equipment and installation costs with consideration given to foundation and floor space requirements, man-hours required to install, etc. If practical, the rectifier transformer should be designed for the utility

Figure 5 — One line diagram shows arrangement of 250-volt ,pumpless rectifier unit substation.



distribution voltage to save a double transformation. If this can be done, the cost of transformer kva to step down to the motor-generator set motor voltage should be added to the cost of the motor-generator set. If capacitors must be added for rectifier power factor correction, their cost should be added to the cost of the rectifier.

2. *Operating cost*—The type of power contract in its treatment of power factor, will be important. Other factors are operating efficiency, losses during light load periods, maintenance, downtime, etc. If there are any operational disadvantages peculiar to either equipment, they should be estimated as closely as possible.

2A. *Performance*—It is difficult to evaluate some operating characteristics, such as regulator response, but some consideration should be given to them.

3. *Power system*—The effect of power and reactive peaks on the system should be evaluated and consideration should be given to the possible effect of rectifier harmonics. Fault contribution from motor-generator sets may be an important factor in power system design. Excessive a-c voltage swings can effect rectifier transformer design.

An analysis based on the above criteria will give valuable information which will help in making the proper decision. Since this class of equipment has a life of many years, it is only right that all appropriate factors be considered before investing. It will be important to use modern principles of investment and capitalization in evaluating the differences in initial and operating costs between the two types of equipment.

APPLICATIONS

Based on the above characteristics, typical applications for rectifiers can be listed as follows, with the order determined by first cost:

1. Constant voltage rectifiers for general purpose loads where a great variety of d-c motor load is connected to a constant potential d-c bus through suitable starting and protective means.
2. Adjustable voltage rectifiers for non-reversing main roll drives. This application is most economical where the mill speed range is obtained by motor field weakening only, and the rectifier operates below rated voltage only when starting the mill. Continuous operation at reduced voltage can be obtained by the use of open circuit or load tap changing equipment.
3. Motor drives requiring reduced voltage operation where the need for rapid voltage change would not permit the use of open circuit taps or load tap changing equipment.
4. Motor drives requiring frequent reversal.
5. Motor drives where continuously controlled regenerative braking is required.

CONSTANT POTENTIAL RECTIFIERS

The first mercury-arc rectifiers used in the steel industry were for supplying constant potential power at 250 volts for plant d-c distribution systems where the load consisted primarily of mill auxiliary drives, cranes, etc. They have proved themselves exceedingly reliable in this type of service and it is a rare thing today when anything but a mercury arc rectifier is selected for constant potential service. Standard rectifier equipment for this application is rated 100 per cent load continuously, 125 per cent, 2 hours and 200 per cent, 1 minute. Regulating equipment to maintain constant voltage d-c is standard and the rectifier transformers are designed so that rated d-c voltage can be maintained at rated load even though the a-c system voltage may be 5 per cent low. These equipments are supplied complete with all of the auxiliary devices required for the reliable operation and protection of the equipment. Annunciators, or self-indicating protective devices, are provided to sound the alarm in the event of any abnormal operating condition such as loss of cooling water, transformer over-temperature, etc. A-c and d-c circuit breakers are provided to protect against internal faults and d-c short circuits. Anode breakers are also provided when conditions require them.

The problem of when and where to use anode breakers is not always clearly understood. The fact that they give reliability when an arc-back occurs is well understood, but there are other times when anode breakers are recommended. One of the major advantages of high speed anode protection is to keep the mechanical stresses due to a fault current to a minimum and thus prolong transformer life. It is generally agreed that transformers up to and including 2000 kw can withstand the stresses produced by their own fault current contribution. A single unit larger than 2000 kw should be protected by high speed anode breakers so that the fault is removed as fast as possible.

Since paralleled rectifiers or other converting equipment will also contribute d-c fault currents to a unit involved in an arc-back, there must also be a limitation on total bus capacity. Even though a 2000-kw or smaller transformer could withstand its own contribution, its windings must be protected against the total fault current which includes the contribution from the d-c system. If the total connected bus capacity exceeds 3000 kw, anode breakers are recommended. This means a total of 3000 kw at the rectifier bus. If other converting equipment is located remotely from the rectifier equipment, the effect of the cable or bus tie in reducing the equivalent capacity at the rectifier bus should be considered. In addition to the primary advantages of service continuity and reduced mechanical stresses, additional advantages of anode breakers are reduced commutating duty on the rectifier, reduced possibility of simultaneous arc-backs in paralleled rectifiers, and reduced maintenance on the a-c and d-c breakers since they do not operate to clear arc-backs.

Standard rectifiers can be operated either as attended or unattended equipments. If operated unattended they will automatically shut themselves down in the event of abnormal conditions which are not corrected. This feature lends itself well to the use of supervisory equipment to control the unit automatically from a remote location. If trouble occurs, the alarm can be sounded at the remote control point and an operator sent to correct the trouble before the rectifier trips off the line. Whether or not this feature is of any value

depends primarily on the location of the equipment. If the rectifier is located in a motor room which would normally be attended, there is not much justification for the expense of supervisory control. On the other hand, there are probably applications where the rectifiers can be put off in a vault by themselves, perhaps at a load center such as an ore unloading dock, and then the remote control feature would be attractive. Other operational features which are available at additional expense are equipment to permit parallel operation with existing rectifiers or motor-generator sets, and automatically controlled dynamic braking equipment which is connected across the d-c bus to prevent over-voltage when regenerative loads are pumping back into the d-c system.

One of the most important factors to consider in installing d-c distribution systems is the problem of fault currents. There is no reason for treating a d-c distribution system differently from an a-c distribution system. Both systems should be designed in accordance with modern load center principles. In the past, it was convenient to locate a number of motor-generator sets in one area so that one attendant could look after them. The fault currents at some installations of this type, where the generating capacity may be as high as 4500 kw, can be well over 200,000 amp from the power source alone and the contribution from the connected motor load can contribute another 150,000 to 200,000 amp. The other disadvantage of the powerhouse system is, of course, the voltage drop and losses in the feeders out to the centers of the load. The advantages of load center distribution systems can be as great in d-c systems as they are in a-c systems and merit study and consideration.

Naturally, with isolated load centers, the question of reliability comes up. Using an isolated rectifier installation with a normally open tie to the rest of the d-c system, the best way to assure reliability is to have anode breakers. Arc-backs are pretty rare on 250-volt systems, but if there is liable to be an expensive loss due to the unexpected shutdown of the equipment, then anode breakers can be justified. Other rectifier difficulties will always indicate themselves by an alarm first before shutting the equipment down so that there would be plenty of time available for someone to go to the equipment and close the tie breaker to the rest of the system.

MAIN ROLL DRIVES

Now for the more glamorous application of rectifiers in the steel industry, the main roll drives. The history of these applications is somewhat as follows: They were first paralleled with existing generators on hot strip mill common bus systems. Later, they were used as the sole supply in common bus and split bus installations for tube mills, merchant mills, skelp mills, hot strip mills, and rod mills.

Figure 6 shows a recent hot strip mill installation in which the armature circuit of each stand is entirely independent. The advantages of this system are the simplification of costly high current buswork, the reduction in the number of circuit breakers, the reduction of fault currents, and the additional flexibility in speed cone provided by individual voltage control of each stand. This mill uses five 4000-kw rectifiers with five 5000-hp motors on the first five stands and a 2800-kw rectifier and 3500-hp motor on the sixth stand. Figure 6 shows the one line diagram of the system with the primary a-c switchgear, phase shifting transformers to reduce the possibility of telephone interference, transformers with tap changing under load providing voltage control down to 60 per cent of rated, rectifier transformers, anode breakers which are always furnished on main drive equipments, rectifiers, d-c breakers, and finally the stand motors.

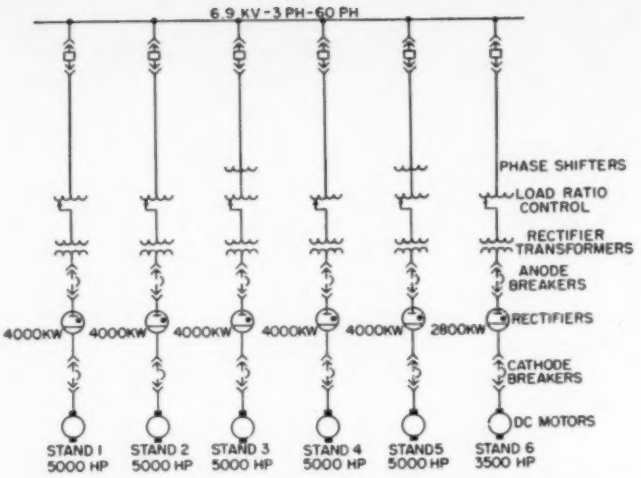


Figure 6 — One line diagram shows rectifier system for hot strip mill service.

Figure 7 is a closeup of one of the 4000-kw rectifiers looking into the tank and heat exchanger sections. The compartments with the doors closed are the rectifier excitation cubicle, auxiliary control and cathode breaker. Rectifier equipments for main drive service are rated 100 per cent continuously, 125 per cent for 2 hours and 200 per cent for 1 minute. D-c voltage-regulators are always provided, and are more accurate and have a faster response than the standard regulator equipment supplied with constant potential rectifiers. Anode breakers are used to provide maximum service

Figure 7 — This 4000-kw, pumpless rectifier for hot strip mill service is used on installation where armature circuit of each stand is entirely independent.

reliability. The rectifier transformers are designed so that rated voltage can be maintained at 175 per cent load with 95 per cent a-c voltage for applications such as hot strip mills where the load peaks are frequently 175 per cent of rated load. For rolling mill applications where the load peaks are smaller and less frequent, such as multiple strand rod mills, the d-c voltage can be maintained at 125 per cent load with 95 per cent a-c voltage.

The voltage regulating transformer is controlled to compensate for changes in a-c system voltage and also for changes in d-c voltage as adjusted by the mill operator. Tap changing under load permits change of voltage level without shutting down the mill. An alternate and less expensive scheme for obtaining operation at reduced voltage is to use open circuit taps on the rectifier transformer. This method requires that the mill or stand be shut down since the a-c breaker must be opened before the taps can be changed. We have supplied both systems for hot strip mills, the open circuit tap system for a rod mill, and will soon install a load tap changing system for another rod mill. Selection of one over the other is determined primarily by the manner in which the mill will be operated. If schedule changes are expected to be infrequent, open circuit taps would be preferred. If rolls have to be changed when the schedule is changed, then open circuit taps would be satisfactory. If schedule changes are frequent, and the change in voltage level must be accomplished in the minimum time, then load tap changing equipment is recommended.

REVERSING DRIVES

In this country the application of rectifiers to large main roll drives has so far been limited to those which are non-reversing and which are not required to accelerate very often, or with load, and where deceleration by dynamic braking is permissible. In Europe, rectifiers have been used, or are being built, for practically all rolling mill applications. They have been used for blooming and slabbing mills as well as for many of the mill auxiliaries, including screwdowns, ingot buggies, table rolls and shears. For these applications they generally use a single rectifier with armature reversal requiring rectifier and inverter operation with one unit.

Inverter operation means controlling the rectifier and its load in such a way that d-c power supplied by the load is changed into a-c power and pumped back into the a-c system. This provides controlled regenerative braking of the motor in a manner analogous to the regenerative braking obtained by a motor pumping back into a generator. The major difference of course, is that the current can flow in only one direction in a rectifier so that power reversal has to be accomplished by reversing the voltage. The basic fact to remember is that a rectifier anode can start to conduct whenever it is more positive than the cathode. During inversion the motor polarity is reversed so that the positive terminal of the motor is connected to the anode through the transformer winding. This makes the anode positive with respect to the cathode when the a-c voltage wave is negative, and power will flow from the motor

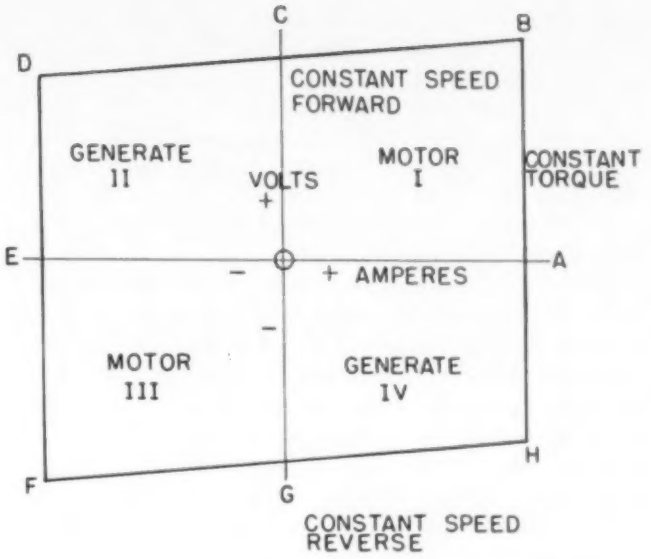


Figure 8 — Operation chart of a d-c, motor-driven, reversing drive.

and be transformed into a-c power regenerated back into the a-c system. Correct timing of the start of anode conduction assures the proper relationship between the motor voltage and inverter counter-emf.

There are three methods of obtaining the voltage reversal required for inverter operation. The most common method is to reverse the motor armature connections. This requires a heavy duty switch capable of extremely fast and frequent operation. Switching is done at zero current, so the only wear on the contacts is mechanical and arc chutes are not required. Another method is to reverse the motor field which reverses the internal motor voltage accomplishing the same result as switching the armature leads. The disadvantage of this method is the comparatively long time required due to the field inductance. A third method is the use of two complete rectifiers supplying current in opposite directions. Using pumpless or sealed rectifiers this can be done with two sets of tanks and control with only one rectifier transformer. Each rectifier supplies power for operation in one direction and acts as an inverter to absorb regenerated power during reversal or slowdown from the other direction. No switching of motor armature or field circuits is required, the necessary changes between rectifier and inverter operation being made in the rectifier excitation circuits. The disadvantage of course is that two sets of rectifier tanks are required which is expensive and requires additional floor space.

Figure 8 shows the operation chart of a d-c motor driven reversing drive. The upper right quadrant shows motor speed in the forward direction with rectifier and motoring action. When the drive is reversed, the rectifier voltage is reduced, the current goes rapidly to zero, and the armature reversing contactors are reversed at zero current. The rectifier then operates as an inverter on current limit and pumps power back into the a-c system bringing the drive to a stop. The control proceeds smoothly into rectifier operation accelerating the motor up to speed in the reverse direction in the lower left quadrant and continues there

until the drive is required to reverse again and the sequence is repeated. Similar inverting action is required when the drive is decelerated from top speed to some lower speed, but not reversed.

For some applications in Europe, two rectifiers have been supplied in cross connection, with each rectifier providing power for rolling in one direction and operating as an inverter during reversal from the other direction. From a control standpoint, the basic difference between the two arrangements is that two rectifiers in cross connection will provide continuously controlled deceleration, whereas one rectifier with an armature reversing switch will not give continuity of control due to the fact that the armature circuit is opened by the reversing switch. On a tandem cold reduction mill, for example, where controlled deceleration holding tension is required, two rectifiers are needed. A reversing cold mill would likewise require two rectifiers. Any application requiring a current limit stop with a definite speed match required between stands, or between a reel and a stand, would require two rectifiers. For a reversing application where the material leaves the mill and the continuous control of current is not required, the single rectifier with armature reversal can be used.

The basic reason for the much wider use of rectifiers in Europe is their efficiency which European designers use to advantage in many cases by selecting higher operating voltages than are normally used in this country. European power costs are much higher than in this country and their labor costs are much lower. Consequently, the power cost represents a much greater percentage of the cost of production. Thus, in Europe, more weight is given to the second criterion for selection of rectifier equipment, operating costs, than is done in this country. The third criterion, the power system, has to be considered very carefully where rectifiers are supplied for large reversing drives. The power and reactive peaks are transferred directly to the system with rectifier power supplies, whereas motor-generator sets would normally be driven by induction motors with flywheels which would shield the power system from load peaks.

ELECTRONIC MOTOR DRIVES

Another type of rectifier equipment for steel mill use is a class known as electronic motor drives. This equipment uses small sealed tube rectifiers and is available in ranges from 100 to 600 hp.

These drives are furnished as packaged units and are designed for operation directly from a 480 volt, 3 phase power system, Figure 9. Operated in this fashion they do not require a rectifier transformer, but will convert 480 volts a-c to approximately 600 volts d-c and standard motors can be used. The double way rectifier circuit is used which provides a 6-phase output giving the same d-c voltage characteristic as the more familiar 6-phase, single way circuit.

We recently supplied this type of equipment for a small reversing mill for one of our laboratories. The mill is driven by a 250-hp motor. Motor reversal is obtained by armature reversing contactors, and the rectifier operates both as a rectifier and an inverter as described earlier. The drive uses an all magnetic amplifier control scheme and reversal times in the order of 2 seconds from top speed to top speed have been obtained. The mill uses voltage control entirely for its speed range, and is rated 250 hp at 230 volts and 600 hp at 550 volts.

That completes the story on mercury arc rectifiers. For 250-volt constant potential service in steel mills they are the accepted standard. For main roll drive applications they are especially suitable for non-reversing mills infrequently started and stopped. It is possible to use them for practically every steel mill drive, but whether or not it is advisable will depend upon the three engineering and economic criteria outlined previously, the initial investment, the operating cost and the power system.

METALLIC RECTIFIERS

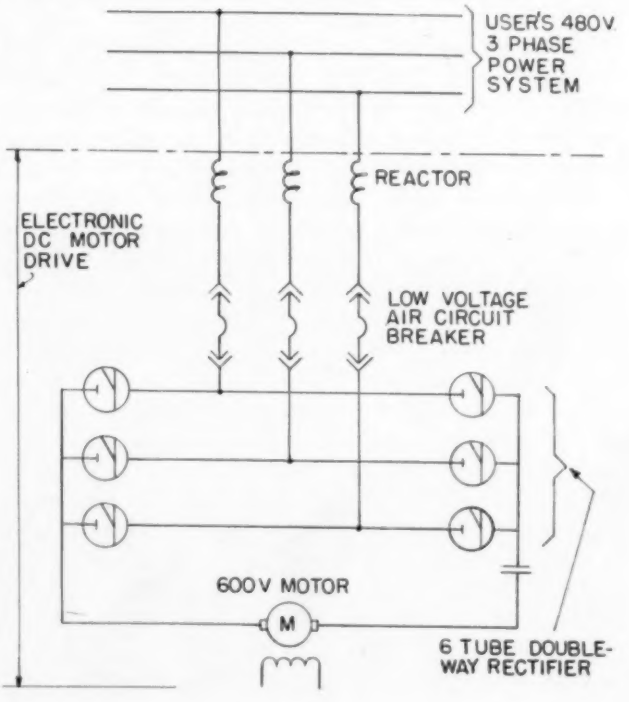
The category of metallic rectifiers embraces a variety of semi-conductor devices using different materials and having different properties. Three types are in common use at this time: copper oxide, selenium, and germanium. Silicon is approaching commercial use.

Description of rectifier cells—A semi-conductor device or cell consists of a flat plate of a suitable metal treated at one or both surfaces with another material which sets up a blocking action to flow of current in one direction with little resistance to flow in the other direction.

The copper-oxide cell is formed from a plate of copper having an area ranging from a fraction of a square inch to 30 sq in. One of the surfaces is oxidized and rectification takes place at the junction between the copper and the copper oxide.

Selenium rectifier cells are formed by depositing metallic selenium on plates of aluminum or steel and forming a rectifying junction between the surface of the selenium and a sprayed metal counter electrode.

Figure 9 — This double-way rectifier system unit converts 3-phase, 480-volt, a-c power to 600-volt, d-c power.



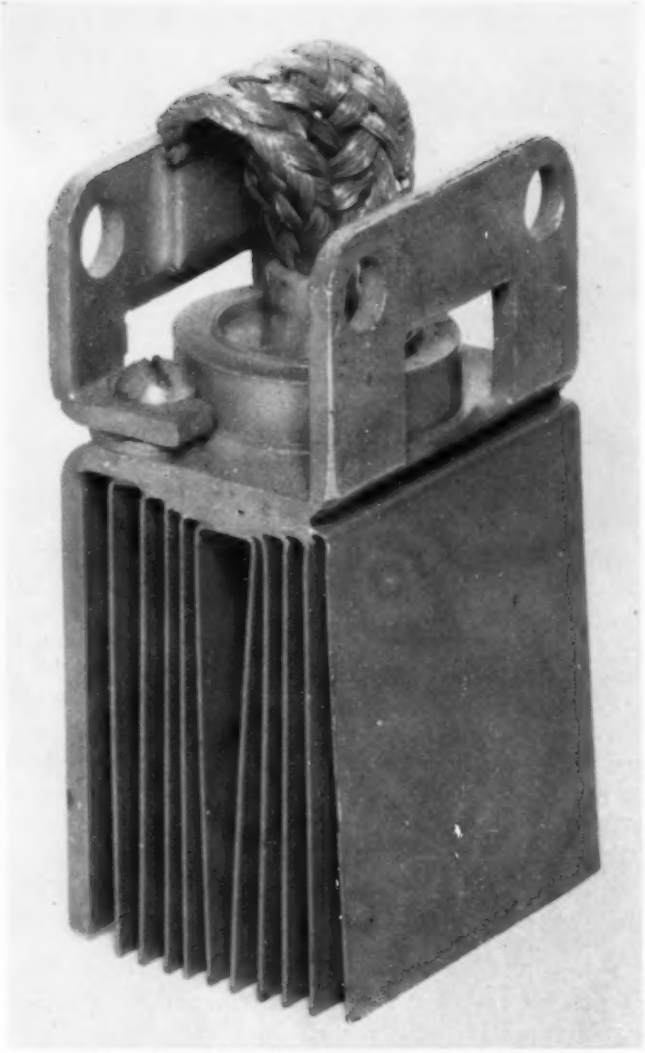


Figure 10 — Liquid cooled hermetically sealed germanium rectifier cell is rated 83 amperes average.

Cells are manufactured in the same range of physical sizes as copper oxide cells.

Germanium and silicon rectifier cells consist of wafers about 20 mils in thickness and a ¼ sq in. in area, alloyed to suitable materials at the two surfaces and mounted in a hermetically-sealed capsule. This capsule is secured to large copper members for ready removal of heat. Figure 10 shows the assembly of a germanium cell to a copper-finned mounting designed for liquid cooling.

CHARACTERISTICS OF SEMI-CONDUCTOR CELLS AND EQUIPMENT

Voltage—The dielectric strengths of the blocking layers of the cells described above are not the same. Their breakdown voltages may be translated into maximum permissible output voltage from a 6-phase double-way rectifier using a single cell for each rectifying element. These d-c voltage values are approximately 12, 30, and 75 for copper oxide, selenium, and germanium respectively.

Temperature—Excessive temperatures cause damage or failure. Copper oxide and selenium cells undergo an aging process, which results in an increase in forward voltage drop. Life of these rectifiers is the time for the initial drop to double. Normal life expectation is

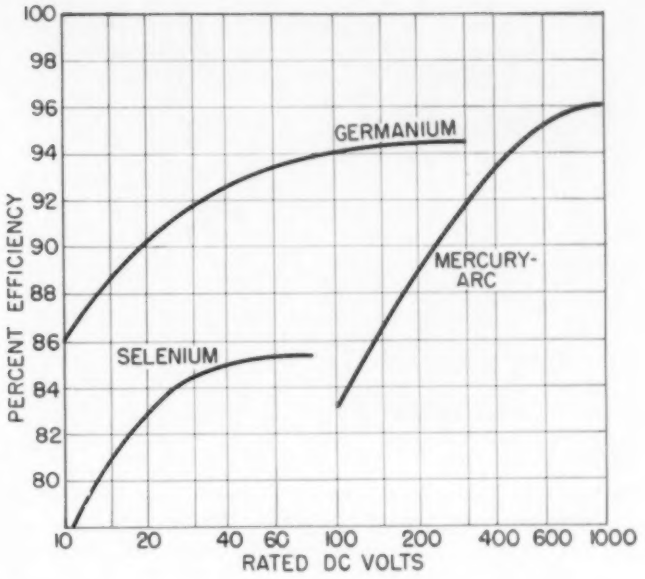


Figure 11 — Curves compare efficiency of rectifier equipment.

60,000 hours. Moderate overtemperature accelerates the aging of selenium. Germanium and silicon do not age.

Excessive overtemperature lowers the dielectric strength of all forms of metallic rectifiers and may cause voltage breakdown at normal operating voltage. Silicon can withstand higher temperatures than other metallic rectifiers.

Current—The optimum current density in a specific semi-conductor material depends on the volt-ampere characteristic and the cost of the material. The aging of selenium is accelerated at high current densities.

Copper oxide and selenium are usually operated between ⅓ and ⅔ amp per sq in. depending on the method of cooling, while germanium and silicon are operated at several hundred amp per sq in.

Cell ratings—Voltage ratings of various types of cells are sufficiently lower than the breakdown voltage to allow for transient surges of voltage or current and unfavorable operating conditions. Current ratings are related to cooling methods. Copper oxide and selenium may be cooled by natural or forced convection. Germanium and silicon employ strong forced convection or liquid cooling.

The requirements of most applications are such that cells must be connected in parallel or series or both. The equivalent kilowatt rating of a germanium or silicon cell is about 3 kw at rated voltage. In the case of copper oxide and selenium, the figure is about ¼ kw for the largest cells made in this country.

Protection—Rectifier equipment is subject to overloads, external faults, and internal faults caused by faulty cells. The thermal capacity of copper-oxide and selenium rectifier cells permits the use of conventional methods of fault interruption. Germanium and silicon cells require high speed protection against internal faults because of their very limited fault capacity. This is usually accomplished by means of current-limiting fuses, using a fuse for each cell or each pair of parallel cells. With this arrangement, an internal fault will clear the faulty cell and permit continuation of operation

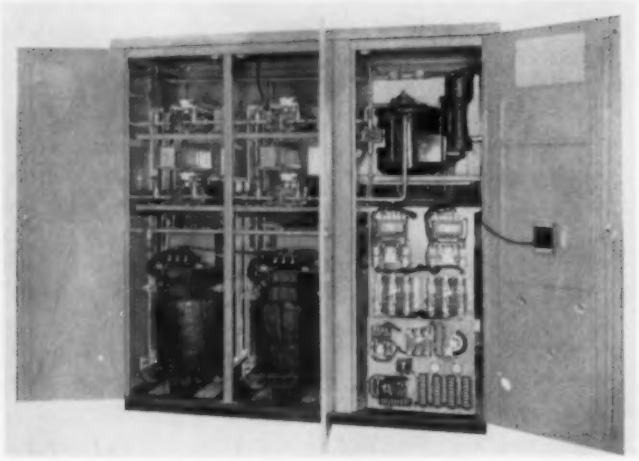


Figure 12 — This metal enclosed germanium rectifier is rated 480-volt, a-c; 12 to 24 volt, 6000-amp d-c.

at reduced load, depending on the total number of parallel cells.

Efficiency—At d-c voltages below the capability of a single cell, the efficiency of metallic rectifier equipment will depend on the d-c voltage and the voltage drop in the cell. Thus, the copper oxide rectifier cell reaches its maximum efficiency at about 12 volts d-c. Selenium and germanium rectifiers reach peak efficiency at considerably higher voltages. Figure 11 shows typical values of efficiency of selenium and germanium rectifiers, together with comparative values for mercury-arc rectifiers.

Voltage control—Metallic rectifiers have no inbuilt control elements such as grids or ignitors, which permit voltage control of mercury-arc rectifiers. (Transistors may be regarded as control devices rather than power conversion devices and hence have been excluded from this discussion.) Two methods of voltage control are available:

1. The a-c voltage to the rectifier transformer may be controlled by an induction regulator or regulating transformer. This is the preferred method in cases where high response speed in the control system is not required since it involves no reduction in power factor.
2. When the d-c system is subject to faults, full-range saturable reactors are often used for control, since they add current-limiting action to the circuit and prevent damage to cells without calling the fuses into action. A regulating system working into saturable reactors will have fast response and will give accurate control of the process.

From the above description of metallic rectifier characteristics, it is evident that many properties of mercury-arc rectifiers are common to metallic rectifiers. The more important differences which help to define the respective fields of application are:

1. Efficiency of germanium rectifiers is 90 per cent or better at d-c voltages of 24 or less.
2. Failure of a metallic rectifier cell is permanent. It cannot be returned to service.
3. High-speed voltage regulating means used for mercury-arc rectifiers are not applicable to metallic rectifiers.
4. Metallic rectifiers have more limited fault current and short time overload capacity than mercury-arc rectifiers.
5. Metallic rectifiers are incapable of inverter operation.

STEEL INDUSTRY APPLICATIONS

The application field for power conversion equipment in the steel industry may be divided into three groups:

1. Adjustable-voltage applications under 125 volts d-c.
2. Constant-voltage applications at 250 volts.
3. Adjustable-voltage applications, 250-750 volts d-c.

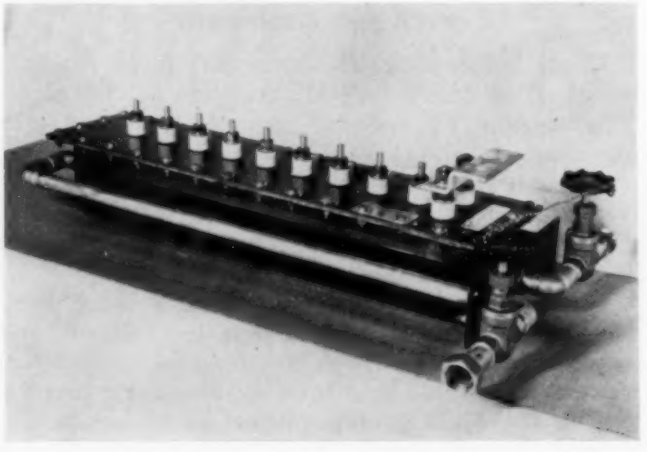
1. Germanium rectifiers compare most favorably with other conversion means in the low-voltage field, in the range from 12 to 125 volts. This voltage range covers such applications as tinning, electrolytic cleaning, plating, and hydrogen production. In this range, over-all efficiencies of 88 to 94 per cent can be expected, depending on the d-c voltage.

Other available conversion means in the low-voltage heavy-current field are generators and selenium or copper oxide rectifiers. Germanium has a considerable efficiency advantage over both these. It does not age, as do selenium and copper oxide. An important advantage over generators in unfavorable atmospheres is that the rectifiers can be located close to the work, eliminating the need for a separate generator room and for long heavy-current leads to the work.

Figure 12 shows a germanium rectifier designed for operation from a 480-volt supply through an induction regulator, and having an output of 6000 amp at 12 to 24 volts. The rectifier cells are mounted in rectangular trays through which a cooling fluid is pumped. Figure 13 shows one of the trays. The pump and heat exchanger are mounted in the upper right-hand section of the enclosure. This rectifier is part of a 40,000-amp installation for anodizing.

Figure 14 shows a 4,000 amp, 65-volt germanium unit similar to several units in use by the steel industry for hydrogen production, and supplied at 480 volts. Figure 15 shows a larger unit for hydrogen production, supplied directly from a 13.8-kv source. Two such

Figure 13 — Tray contains 18 liquid cooled germanium rectifier cells for assembly in unit shown in Figure 12.



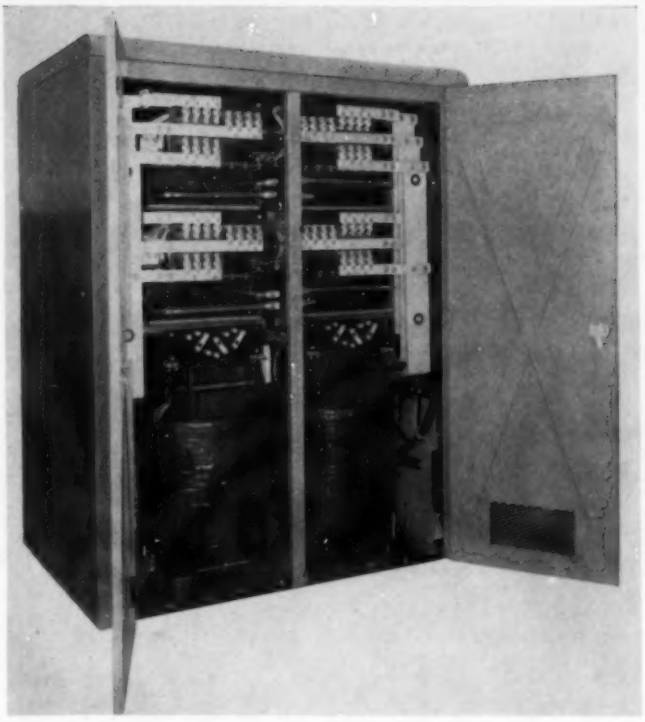


Figure 14 — This metal enclosed germanium rectifier is rated 480-volt a-c; 65-volt, 4000-amp d-c and is used for hydrogen production.

units, each rated 65 volts, 15,000 amp, are installed at this location. The transformers and induction regulators are located outdoors.

Figure 16 shows a 12-volt, 5000-amp germanium unit used in a tinning line. The operation of this unit during the past year has given valuable information both to the manufacturer and to the user.

2. In the 250-volt constant potential field, the germanium rectifier shows an efficiency advantage of several per cent over mercury-arc rectifiers and is thus a potential candidate for this business. Before it can be seriously considered, however, application problems in the areas of protection and regulation need to be solved.

3. In the higher voltage area, where accurate high-speed regulation is often required, it is improbable that the germanium rectifier will ever match the performance of the mercury-arc rectifier. The economic burden of the devices required for high performance would more than wipe out any small gain in efficiency. The germanium rectifier is incapable of having its voltage reversed so as to vary the direction of power flow and so cannot be used to control reversing drives.

We may conclude, then, that the greatest immediate use of metallic rectifiers in the steel industry will be in the field of adjustable-voltage applications under 125 volts.

Figure 15 — This rectifier unit is supplied directly from a 13.8-kv source.

THE AGES OF CONVERTERS

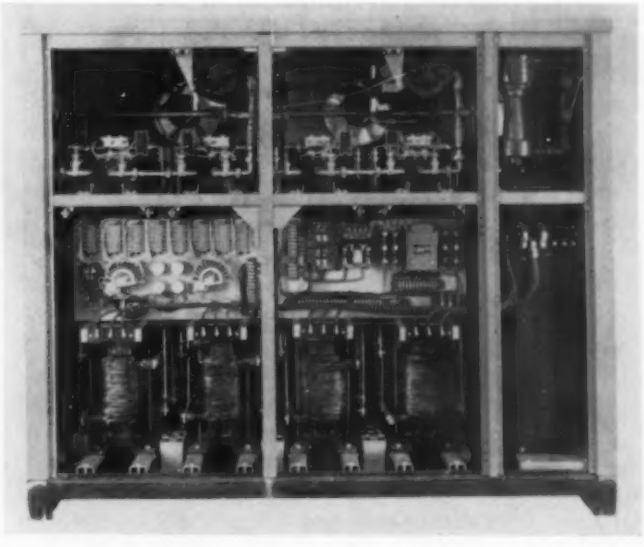
In appraising the principal forms of conversion equipment now available, one might consider the time that these various forms have been with us, in other words, their age, and then compare them with the ages of man.

Thus we find the rotating machine to be the patriarch of the family. Its characteristics are well known. While susceptible to minor improvements, its general pattern is pretty well fixed, and no important developments affecting its application are likely.

The mercury-arc rectifier is the energetic young man of the family. It has reached its majority; and, in spite of having spread its weight about during the last decade, it still finds new applications to prove its superiority.

The semi-conductors are the children of the family. The older ones, copper oxide and selenium, never got to college, but they lead useful lives nevertheless, performing tasks that could not be turned over to the high-powered folks. The smaller children, germanium and silicon, are much more precocious, and more is expected of them when they grow up. They still need indoctrination regarding the importance of character (reliability) in later life. We must not forget the youngest sibling in the family—the transistor. This infant has not developed to a point where we can determine whether it was sired by a pygmy or a giant and hence, whether it will live by cunning instead of power, when it grows up.

Figure 16 — The 12-volt, 5000-amp germanium unit shown is particularly applicable for use on tinning lines.



COKE AND BY-PRODUCTS IN 1955

By I. E. MADSEN

. . . . data and material in this report are based on information or quoted from Mineral Market Reports M.M.S. No. 2520, July 1956; M.M.S. No. 2540, August 1956; M.M.S. 2500. May 11, 1956 and M.M.S. No. 2516, June 1956 . . . .

▲ PRODUCTION of coke in the United States in 1955 totaled 75,301,826 net tons, according to data supplied by coke-producing companies to the Bureau of Mines, United States Department of the Interior. Thus the coke industry made a significant contribution to the industrial economy of the United States in 1955 by increasing its output 26 per cent over the 1954 total. This gain in coke output was less than the 33 per cent rise in pig-iron production; but was higher than the 11 per cent advance in physical volume of industrial production reported by the Federal Reserve Board. The substantial rise in industrial activity, particularly at blast-furnace operations, increased metallurgical-coke requirements which, in turn, influenced coke production. This development resulted in the second highest output of oven coke on record falling short by only 9,314 net tons from the previous maximum of 1953. The operating rate of slot-type coke ovens rose steadily throughout the year reaching the highest level on record in December when output averaged 214,500 net tons daily.

Production of beehive coke in 1955 was only about one-third the average of 1947-49, but was nearly three times higher than in 1954. Lack of satisfactory coking coal caused most of the beehive plants with serviceable ovens in the Connellsville District of western Pennsylvania to remain idle in 1955. Virtually all the beehive ovens that had sufficient high-grade coals were in blast by Dec. 31 and rate of production in December was more than five times greater than in December 1954.

Metallurgical-coke requirements rose steadily throughout the year and kept demand slightly ahead of production. Consequently, stocks of coke at producers' plants decreased 1,200,000 tons during the year. The withdrawal of coke from producers' plants inventories and the favorable coke-to-pig ratio kept coke shortages at a minimum. Although pig-iron production exceeded the previous maximum of 1953 by nearly 2,000,000 tons, 1,600,000 tons less coke was charged into blast furnaces. This savings was due to a reduction in coke-to-pig-iron ratio from 1834.9 lb of coke per ton of pig iron, including ferroalloys, in 1953 to 1761.3 lb in 1955. While this reduction appeared small, it was equivalent to a savings of nearly 2,900,000 tons of coke in 1955. In spite of the favorable coke-to-pig rate, blast furnaces used the second largest quantity of coke on record, and shipments of furnace coke were 21 per cent above the 1947-49 average. Shipments to iron foundries increased 27 per cent over 1954, but were 139,249 tons or four per cent below the 1947-49 level. The surge in industrial activity raised coke requirements in virtually every other industrial application except for gas manufacture. The use of coke for manufacturing producer gas and water gas declined; but the drop was more than offset by the rise in tonnage used by other industrial consumers in 1955. Thus total disposal from producing plants for all other industrial purposes (including producer gas and water gas) increased 11 per cent over 1954, but was only about one-half the volume distributed to the same class of consumers in 1947-49. Shipments of coke for domestic heating decreased for the tenth consecutive year and were the smallest on record. According to data obtained from coke-producing companies, blast-furnace coke used and sold by producers represented 89 per cent of total disposal; four per cent was destined to iron foundries; 1.6 per cent to producer- and water-gas plants; 3.4 per cent to miscellaneous other industrial plants; and 1.5 per cent for residential heating.

Construction of coke ovens and related facilities continued at a high rate in 1955, but the net gain in carbonizing capacity of slot-type coke ovens was small because most of the new ovens installed were replace-

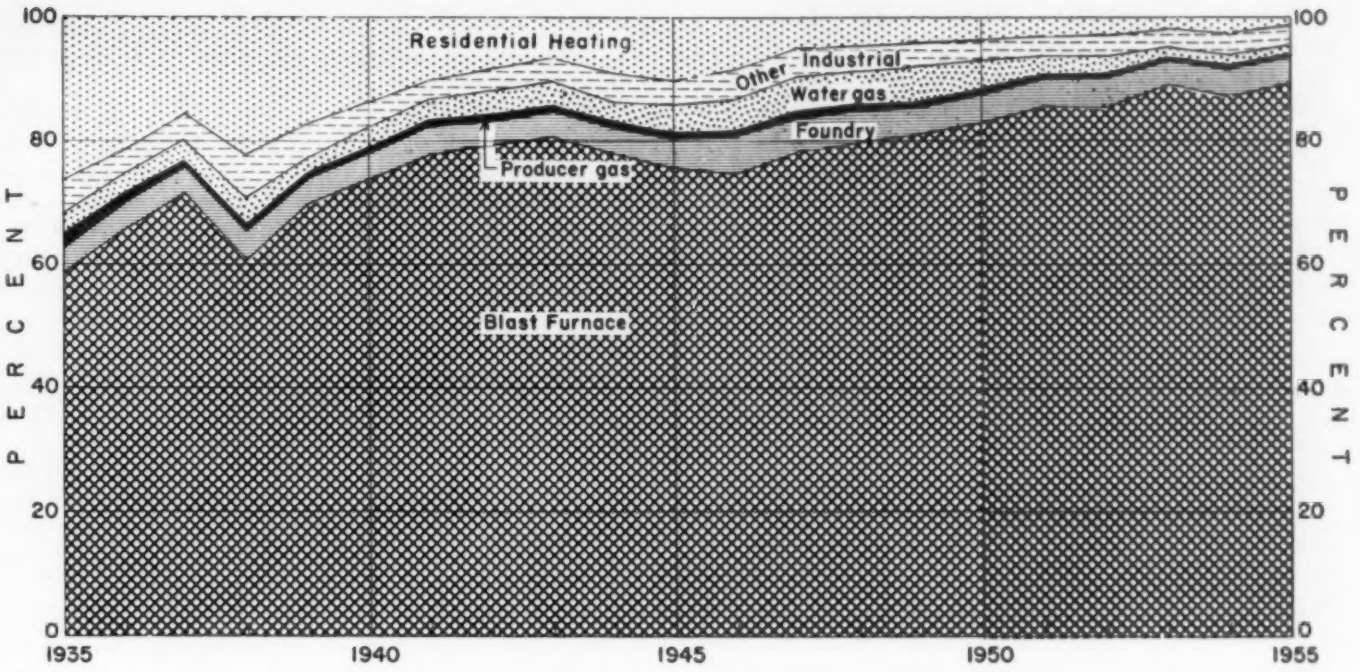


Figure 1 — Percentage distribution of oven and beehive coke (exclusive of breeze) is given by principal uses for period 1935 to 1955.

ments. The industry gained 148 additional ovens which raised the total number of active slot-type ovens in existence on December 31 to 16,039 with an annual coke capacity of 79,700,000 net tons. In addition, five batteries consisting of 261 ovens with a potential annual capacity of 1,500,000 net tons were under construction at the end of the year. Practically all of the new coke ovens placed in operation since December 31, 1950, were built under By-Product Coke Expansion Goal No. 4 promulgated by the Defense Production Administration on December 5, 1951. During 1955, the Office of Defense Mobilization (successor to DPA) issued Supplement 1 to Defense Mobilization Order VII —6 on August 11 which closed 19 expansion goals and suspended 38 others. Among the 38 expansion goals suspended was Expansion Goal No. 4—By-Product Coke. This action was taken by ODM so that a review of the goal could be made to determine whether adequate productive capacity existed to meet mobilization needs. The goal was officially closed on September 29, 1955, under terms described in Supplement 3 to DMO-VII-6.

The substantial rise in quantity of coal carbonized in slot-type coke ovens (24 per cent) caused output of the primary coal-chemical materials (coke-oven gas, ammonia, crude tar, and crude light oil) to increase proportionately. Coke-oven gas advanced 25 per cent over 1954; ammonia, 18 per cent; crude tar, 19 per cent; and crude light oil, 21 per cent. These increases were due entirely to the greater quantity of coal charged into ovens, as yields of all products except gas were lower than in 1954. The increased supply of crude tar and light oil, however, resulted in increases in output of tar and light oil derivatives ranging from 17 per cent for creosote oil to 84 per cent for crude naphthalene.

Sales of all of the coal chemicals, with the exception of ammonium sulphate, kept pace with production and stocks did not change greatly from the preceding year. Ammonium sulphate sales dropped 109,000,000 lb below production and caused producers' stocks to increase to 418,000,000 lb on December 31 in spite of a price drop of about $1.25 per ton. Naphthalene production rose substantially in 1955 as increased requirements of the industrial grades for making phthalic anhydride kept demand high and influenced an increase of $0.01 per lb in price around the middle of the year. Benzene, the principal light oil derivative, moved well after prices were lowered in January, and supply and demand were in close balance throughout the year.

The value of coke, breeze, gas, and coal chemicals used and sold by producing companies in 1955 totaled $1,635,458,903. The dollar value of coal delivered to coke plants amounted to $943,421,410. Thus the value of products made by carbonizing coal at coke plants was $692,037,493 greater than the value of coal from which they were obtained.

Additional statistics are covered under their respective topics in the following sections and in Tables I, II, III, and IV.

PRODUCTION OF COKE

Daily production of by-product coke averaged 202,000 tons compared with 161,700 tons in 1954. Daily production from beehive ovens averaged 4,720 tons per day compared with 1,650 tons in 1954. The increase in production reflected chiefly the increased steel production in 1955. Pennsylvania was the leading state in the production of by-product coke and the other leading producers, in the order of their importance, were Ohio, Indiana, Alabama, and West Virginia. These first five states produced about 69.7 per cent of the national production of oven coke compared with 69.4 per cent in 1954, almost exactly the same propor-

tion as the previous year. Pennsylvania was also the leading producer of beehive coke in 1955 with 1,313,694 tons compared with 432,061 tons in 1954. Pennsylvania beehive production in 1955 was 76.7 per cent of the total or even greater than the previous year's proportion of 71.9 per cent. Pennsylvania was the leading producer of coke with 20,802,687 tons or 27.6 per cent of the total a slight increase over the 26.8 per cent in 1954. This increased percentage reflected the operation of the beehive units in the state.

NUMBER AND CAPACITY OF OVENS

At the end of 1955 there were a total of 16,039 by-product ovens which is a slight increase over the 15,891 at the beginning of the year. These ovens had a capacity of 79,675,500 tons compared with a capacity of 78,595,600 tons at the beginning of the year. Some 565 ovens with a capacity of 2,823,600 tons were completed in 1955. Another 417 ovens were abandoned compared with 866 abandoned in 1954. A total of 261 ovens with the annual capacity of 1,492,000 tons were under construction at the end of the year. New ovens were built in only three states. Ohio led with 308 ovens with a capacity of 1,587,600 tons, Pennsylvania, last year's leader, was second with a total of 252 ovens with a capacity of 1,220,100 tons, and Alabama built 5 ovens with a capacity of 15,900 tons. Of the ovens abandoned during the year, 297 were in Ohio and 120 were in Pennsylvania. Of the new ovens under construction, Indiana had the largest block of 162 with an annual capacity of 905,000 tons.

At the end of the year some 10,104 beehive ovens with an annual capacity of 6,285,300 tons were in existence compared with 12,216 with an annual capacity of 8,077,800 the previous year. This continues the steady drop in beehive capacity over the past few years. Of these ovens, some 8,790 with an annual capacity of 5,516,700 were estimated to be in operating condition. In 1955, 553 beehive units were rebuilt compared with 33 in 1954. The number of ovens abandoned in 1955 was 2,665, slightly under the 2,972 in 1954. Some 31 beehive ovens were under construction in Pennsylvania at the end of the year. All the ovens rebuilt during the year, except one, were in Pennsylvania. Pennsylvania also had the largest number of beehive units in operating condition with a total of 7,492 with an annual capacity of 4,913,000 tons or 89 per cent of all the beehive capacity in operating condition.

The increase in steel demand was not reflected in oven construction. Some of the reason for this was the suspension of the government expansion goals for by-product coke.

COAL CHARGED INTO COKE OVENS

In 1955 a total of 107,743,085 tons of coal were charged into coke ovens. Included in this is a total of

TABLE I

Statistical Trends of the Coke Industry in the United States

	1937	1952	1953	1954	1955
Production:					
Oven coke, net tons	49,210,748	63,850,115	73,593,528	59,061,442	73,584,214
Beehive coke, net tons	3,164,721	4,403,994	5,243,329	601,054	1,717,612
Total, net tons	52,375,469	68,254,109	78,836,857	59,662,496	75,301,826
Per cent oven coke	94.0	93.5	93.4	99.1	97.7
Stocks of coke, end of year, net tons	2,595,287	1,901,657	2,679,708	2,948,840	1,700,771
Exports, all coke, net tons	526,683	792,072	520,252	384,377	530,505
Imports, all coke, net tons	286,364	312,519	157,318	115,781	126,342
Indicated consumption, all coke, net tons	51,271,929	67,355,871	77,695,872	59,124,768	76,145,732
Disposal, all coke sold or used:					
Furnace coke, net tons	36,751,969	58,182,747	69,728,500	51,973,401	68,171,966
Foundry coke, net tons	2,038,822	3,102,446	3,040,971	2,568,561	3,253,927
Other industrial coke (including producer and water gas), net tons	4,597,894	4,648,077	4,006,560	3,472,132	3,848,674
Domestic coke, net tons	8,107,518	1,932,369	1,467,962	1,266,722	1,126,065
Carbonizing equipment:					
By-product ovens in existence, end of year	12,718	15,608	15,989	15,891	16,039
Beehive ovens in existence, end of year	12,194	17,551	15,092	12,216	10,104
By-product ovens under construction, end of year	259	1,075	779	490	261
Cost of coal charged, oven-coke plants average per ton	$3.74	$9.23	$9.24	$9.00	$8.84
Prices of coke:					
Average realization on oven coke sold (merchant sales):					
Furnace coke	$4.34	$16.29	$16.37	$13.83	$14.33
Foundry coke	$8.47	$22.49	$23.87	$23.40	$23.75
Other industrial coke (including water gas)	$6.08	$14.10	$14.00	$12.70	$12.96
Domestic coke	$6.53	$14.75	$15.25	$14.83	$15.10
Yield of by-products per ton of coal charged:					
Tar, gal	8.67	7.74	7.90	8.46	8.13
Ammonium sulphate or equivalent, lb	21.84	19.92	20.09	21.09	20.06
Crude light oil, gal	2.86	2.79	2.90	2.98	2.91
Surplus gas sold or used, M cu ft	6.66	6.35	6.41	6.58	6.58
Average gross receipts for by-products, per ton of coke produced:					
Crude tar sold and used (exclusive of amount used by producers for own use in refining and topping and exclusive of tar derivatives)	$0.502	$0.774	$0.806	$0.923	$0.840
Ammonia and its compounds	$0.326	$0.556	$0.536	$0.605	$0.502
Crude light oil and its derivatives (including naphthalene)	$0.435	$1.149	$1.247	$1.249	$1.195
Surplus gas sold or used	$1.483	$1.921	$2.005	$2.178	$2.120
Total coal-chemical materials (including breeze)	$2.974	$4.98	$5.19	$5.57	$5.62

104,873,873 tons with a value of $927,372,709 charged into by-product ovens and 2,869,212 tons with a value of $16,048,701 charged into beehive ovens. The average value of the coal charged into the slot-type ovens was $8.84 a ton and that charged in the beehive $5.59 a ton. These prices are slightly less than the coal prices for 1954. Of the coal charged into the by-product ovens, some 366,168 tons of anthracite were used with a value of $2,873,095 or an average of $7.85 a ton. The cost of the coal needed to make one ton of coke in the by-product ovens was $12.60 a ton compared with $12.89 in 1954. It took 1.43 tons of coal to make a ton of coke which is exactly the same as in 1954 and in 1953. The cost of coal (1.67 tons) needed to make one

TABLE II

Salient Statistics of the Coke Industry in the United States in 1955

	By-product	Beehive ovens	Total
Coke produced — At merchant plants, net tons	9,094,527	(1)	(1)
At furnace plants, net tons	64,489,687	(1)	(1)
Total, net tons	73,584,214	1,717,612	75,301,826
Screenings or breeze produced, net tons	4,862,225	88,795	4,951,020
Coal charged into ovens, net tons	104,873,873	2,869,212	107,743,085
Average value of coal per ton	$8.84	$5.59	$8.76
Average yield in per cent of total coal charged —			
Coke	70.16	59.86	69.89
Breeze (at plants actually recovering)	4.66	5.54	4.67
Ovens — In existence January 1	15,891	12,216	28,107
In existence December 31	16,039	10,104	26,143
Dismantled during year	417	2,665(3)	3,082
In course of construction December 31	261	31	292
Annual coke capacity December 31, net tons	79,675,500	6,285,300	85,960,800
Coke used by producer — In blast furnaces, net tons	62,195,976	126,988	62,322,964
In foundries, net tons	311,475	—	311,475
To make producer gas, net tons	237,300	—	237,300
To make water gas, net tons	908,675	—	908,675
For other purposes, net tons	590,723	—	590,723
Coke sold — (Commercial sales)			
For blast furnace use, net tons	4,686,067	1,162,935	5,849,002
For foundry use, net tons	2,899,488	42,964	2,942,452
For manufacture of water gas, net tons	86,430	—	86,430
For other industrial use, net tons	1,645,592	379,954	2,025,546
For domestic use, net tons	1,119,466	6,599	1,126,065
Disposal of screenings or breeze —			
Used by producer — For steam, net tons	2,581,803	—	2,581,803
For sintering iron ore, net tons	453,055	—	453,055
For other purposes, net tons	579,408	—	579,408
Sold, net tons	1,170,507	89,408	1,259,555
Average receipts per ton sold (merchant sales)			
Furnace coke	$14.33	$12.57	$13.98
Foundry coke	$23.75	$15.05	$23.63
Water-gas coke	$16.19	—	$16.19
Other industrial coke	$12.80	$13.62	$12.96
Domestic coke	$15.10	$10.75	$15.08
Screenings or breeze	$5.69	$3.48	$5.53
Stocks on December 31, 1952:			
Furnace coke, net tons	1,460,252	2,842	1,463,094
Foundry coke, net tons	47,506	20	47,526
Domestic and other coke, net tons	189,442	709	190,151
Screenings or breeze, net tons	759,103	187	759,290
By-products produced — Tar, gal	852,922,817	—	852,922,817
Ammonium sulphate or equivalent(4), lb	2,091,596,851	—	2,091,596,851
Gas, M cu ft	1,083,624,595	—	1,083,624,595
Burned in coking process, per cent	34.48	—	34.48
Surplus sold or used, per cent	63.61	—	63.61
Wasted, per cent	1.91	—	1.91
Crude light oil, gal	297,497,792	—	297,497,792
Yield of by-products per ton of coal —			
Tar, gal	8.13	—	8.13
Ammonium sulphate or equivalent(4), lb	20.06	—	20.06
Gas, M cu ft	10.33	—	10.33
Crude light oil, gal	2.91	—	2.91
Coal used per ton of coke, tons	1.43	1.67	1.43
Value of coke at ovens	$1,199,630,173	$22,231,455	$1,221,861,628
Value of screenings or breeze	$24,849,962	$309,329	$25,159,291
Value of by-products sold — Tar sold and used by producer	$86,057,352	—	$86,057,352
Ammonia (sulphate and liquor)(4)	$36,951,251	—	$36,951,251
Gas (surplus)	$156,139,766	—	$156,139,766
Crude light oil and derivatives	$78,446,316	—	$78,446,316
Other coal-chemical materials(2)	$30,843,299	—	$30,843,299
Total value of coke and breeze produced and coal-chemical materials sold and tar used by producer	$1,612,918,119	$22,540,784	$1,635,458,903

(1) Not separately recorded.
(2) Naphthalene, tar derivatives, and miscellaneous coal-chemical materials.
(3) Includes idle ovens, not expected to go back into production.
(4) Includes diammonium phosphate and ammonium thiocyanate.

ton of beehive coke was $9.34 compared with $10.49 a ton in 1954. It took slightly more coal to make coke in the beehive oven in 1955 than in 1954, as the rate was 1.67 and 1.63.

The leading states in the mining of coking coal for by-product ovens are, in the order of their importance, West Virginia, Pennsylvania, Kentucky, and Alabama who produced 39,504,760, 37,547,770, 11,818,814, and 8,341,502 tons respectively or 91.2 per cent of the 106,677,857 tons which were mined.

COKE USAGE AND DISTRIBUTION

In 1955 blast furnaces used 68,171,966 tons of coke or 90.5 per cent of the 75,301,826 tons produced and

TABLE III

Summary of Coke-oven Operations in the United States in 1955, by States

State	Oven coke						
	In existence December 31①		Coal carbonized (net tons)	Yield of coke from coal (per cent)	Coke produced (net tons)	Value of coke at ovens	
	Plants	Ovens				Total	Per ton
Alabama	7	1,394	8,539,610	73.13	6,245,253	$121,633,886	$19.48
California	1	225	1,356,513	60.06	814,687	②	②
Colorado	1	257	1,184,889	66.55	788,558	②	②
Illinois	8	711	4,322,907	70.34	3,040,900	51,975,561	17.09
Indiana	5	2,003	13,240,028	71.62	9,482,233	175,815,764	18.54
Maryland	1	687	4,478,535	72.25	3,235,527	②	②
Massachusetts	1	108	778,998	70.71	550,868	②	②
Michigan	4	691	4,579,840	74.70	3,421,141	63,567,315	18.58
Minnesota	3	241	1,425,899	72.18	1,029,228	20,353,909	19.78
New Jersey	2	341	1,376,630	72.10	992,566	②	②
New York	4	862	5,746,871	70.21	4,035,076	57,288,441	14.20
Ohio	16	2,544	16,831,990	69.52	11,701,266	178,656,563	15.27
Pennsylvania	14	4,149	28,512,180	68.35	19,488,993	291,575,557	14.96
Tennessee	1	44	259,239	80.54	208,789	②	②
Texas	2	140	1,042,481	71.25	742,781	②	②
Utah	2	308	2,044,300	65.29	1,334,760	②	②
West Virginia	5	772	6,127,655	70.58	4,324,863	57,182,169	13.22
Connecticut, Kentucky, Missouri and Wisconsin	4	562	3,025,308	70.96	2,146,725	33,793,195	15.74
Undistributed	.....	.....	.....	.....	.....	147,787,813	17.05
Total 1955	81	16,039	104,873,873	70.16	73,584,214	1,199,630,173	16.30
At merchant plants	23	2,482	12,682,370	71.71	9,094,527	152,119,485	16.73
At furnace plants	58	13,557	92,191,503	69.95	64,489,687	1,047,510,688	16.24
Total 1954	81	15,891	84,639,973	69.78	59,061,442	940,769,073	15.93

State	Beehive coke						Total	
	Ovens in existence Dec. 31	Coal carbonized (net tons)	Yield of coke from coal (per cent)	Coke produced (net tons)	Value of coke at ovens		Coke produced (net tons)	Value of coke at ovens
					Total	Per ton		
Alabama	.....	.....	.....	.....	.....	.....	6,245,253	$121,633,886
California	.....	.....	.....	.....	.....	.....	814,687	②
Colorado	.....	.....	.....	.....	.....	.....	788,558	②
Illinois	.....	.....	.....	.....	.....	.....	3,040,900	51,975,561
Indiana	.....	.....	.....	.....	.....	.....	9,482,233	175,815,764
Maryland	.....	.....	.....	.....	.....	.....	3,235,527	②
Massachusetts	.....	.....	.....	.....	.....	.....	550,868	②
Michigan	.....	.....	.....	.....	.....	.....	3,421,141	63,567,315
Minnesota	.....	.....	.....	.....	.....	.....	1,029,228	20,353,909
New Jersey	.....	.....	.....	.....	.....	.....	992,566	②
New York	.....	.....	.....	.....	.....	.....	4,035,076	57,288,441
Ohio	.....	.....	.....	.....	.....	.....	11,701,266	178,656,563
Pennsylvania	8,426	2,124,733	61.83	1,313,694	$16,226,852	$12.35	20,802,687	307,802,409
Tennessee	.....	.....	.....	.....	.....	.....	208,789	②
Texas	.....	.....	.....	.....	.....	.....	742,781	②
Utah	297	213,038	52.33	111,476	②	②	1,446,236	②
Virginia	483	273,968	51.30	140,555	1,995,647	14.20	140,555	1,995,647
West Virginia	703	188,708	60.47	114,107	1,512,241	13.25	4,438,970	58,694,410
Connecticut, Kentucky, Missouri and Wisconsin	195	68,765	54.94	37,780	②	②	2,184,505	②
Undistributed	.....	.....	.....	.....	2,496,715	16.73	.....	184,077,723
Total 1955	10,104	2,869,212	59.86	1,717,612	22,231,455	12.94	75,301,826	1,221,861,628
Total 1954	12,216	979,646	61.35	601,054	8,511,488	14.16	59,662,496	949,280,561

① Excludes plants retired permanently during year.

② Included with "Undistributed" to avoid disclosure of individual company figures.

89 per cent of the 76,145,732 tons consumption. About 843,906 tons came from inventory. This is an appreciable increase over the previous year's usage of 51,973,401 tons and almost as much as the record year of 1953 when 69,728,500 tons were consumed by blast furnaces. Increased production of iron was reflected by corresponding increases in the usage of coke. There was a slight decrease in the amount of coke used per

TABLE IV

Coal-chemical Materials Produced at Coke-oven Installations in the United States in 1955(1)

(Exclusive of breeze)

Product	Produced	Sold			On hand December 31
		Quantity	Value		
			Total	Average	
Tar, crude ..... gal	852,922,817	(2)398,380,071	$45,999,007	$0.115	37,831,031
Tar derivatives:					
Creosote oil:					
Distillate as such (100 per cent creosote) ... gal	26,157,675	26,152,644	5,157,465	0.197	1,506,936
Creosote-coal tar solution (100 per cent solution basis) ..... gal	4,861,419	4,669,936	831,688	0.178	178,153
Creosote content of solution (100 per cent creosote basis) ..... gal	3,802,829	3,635,204	.....	.....	.....
Crude chemical oil ..... gal	26,919,335	27,181,376	6,572,340	0.242	897,790
Phenol ..... lb	13,347,203	11,367,546	1,473,058	0.130	341,961
Pitch of tar:					
Soft(3) ..... net tons	689,656	49,169	1,283,406	26.102	11,663
Hard(4) ..... net tons	433,083	44,527	1,105,019	24.817	2,357
Other coal-tar derivatives(5)	.....	.....	2,703,216	.....	.....
Ammonia:					
Sulphate(6) ..... lb	1,962,652,237	1,853,959,657	36,116,705	0.019	418,042,234
Liquor (NH_3 content) ..... lb	33,241,715	20,009,869	834,546	0.042	3,302,719
Total ..... lb	.....	.....	36,951,251	.....	.....
Sulphate equivalent of all forms ..... lb	2,091,596,851	1,931,577,939	.....	.....	.....
NH_3 equivalent of all forms ..... lb	539,213,462	497,960,669	.....	.....	.....
Gas M cu ft:					
Used under boilers, etc.	(7)1,083,624,595	57,216,555	9,920,113	0.173	.....
Used in steel or allied plants		472,551,419	100,351,821	0.212	.....
Distributed through city mains		70,461,742	27,757,664	0.394	.....
Sold for industrial use		89,118,224	18,110,168	0.203	.....
Total	(7)1,083,624,595	689,347,940	156,139,766	0.227	.....
Crude light oil ..... gal	(8)297,497,792	16,143,851	3,474,210	0.215	5,412,336
Light-oil derivatives, gal:					
Benzene:					
Specification grades (1 degree, 2 degree, and 90 per cent	173,375,369	168,075,176	58,436,051	0.348	7,923,545
Other industrial grades	844,973	675,175	226,820	0.336	74,223
Motor grade	(9)	(9)	(9)		(9)
Toluene (all grades)	38,205,443	36,651,693	10,962,817	0.299	2,794,262
Xylene (all grades)	11,294,085	10,856,948	3,483,848	0.321	817,815
Solvent naphtha (crude and refined)	5,511,382	5,380,357	1,383,294	0.257	329,297
Other light-oil products	6,344,931	3,308,653	479,276	0.145	295,519
Total	235,576,183	224,948,002	74,972,106	0.333	12,234,661
Intermediate light oil ..... gal	3,344,913	3,361,386	648,665	0.193	122,110
Naphthalene (crude):					
Solidifying at less than 74 C ..... lb	38,199,282	37,678,838	1,318,973	0.035	2,109,798
At 74 and less than 76 C ..... lb	17,888,009	8,126,342	404,404	0.050	912,257
At 76 and less than 79 C ..... lb	128,135,747	127,983,604	7,811,795	0.061	1,036,209
Pyridine:					
Crude bases (dry basis) ..... gal	226,325	217,513	242,817	1.116	125,345
Refined (2 C) ..... lb	701,408	722,664	534,186	0.739	257,453
Picolines ..... lb	511,176	434,427	168,012	0.387	98,783
Sodium phenolate ..... gal	3,684,157	3,799,130	490,998	0.129	436,178
Sulphur ..... lb	7,740,040	7,566,840	97,257	0.013	676,690
Value of all coal-chemical materials sold	.....	.....	$348,379,639	.....	.....

(1) Includes products of tar distillation conducted by coke-oven operators under same corporate name.
(2) Includes 38,634,114 gallons sold to affiliated companies for refining.
(3) Water-softening point, less than 110 F. Includes some medium pitch-of-tar reported by 2 producers.
(4) Water-softening point, over 160 F.
(5) Cresols, cresylic acid, pitch coke, resin and red oil, road tar, tar paint, and topped or refined tar.
(6) Includes diammonium phosphate and ammonium thiocyanate.
(7) Includes gas used for heating ovens and gas wasted.
(8) 281,200,190 gallons refined by coke-oven operators to make derived products shown.
(9) Included with "Other light oil products" to avoid disclosure of individual company figures.

net ton of pig iron to 1,761.3 lb compared with 1,763.3 lb in 1954. Since the yield of coke from coal was 69.9 per cent, it took 2,519.7 lb of coal to make one ton of iron and ferroalloys. Total commercial sales of coke for blast furnace use was 5,849,002 tons.

The volume of coke delivered to foundries totaled 3,253,927 tons and this represents 4.3 per cent of the total coke consumed during the year. This compares with 2,568,561 tons in 1954. The amount of coke shipped to producer gas and water gas plants continued the decline prevalent over the past few years and totaled 1,232,405 tons or 1.6 per cent of consumption compared with 2.4 per cent in 1954. The quantity of coke used by other industrial plants totaled 2,616,269 tons (3.4 per cent) compared with 1,499,869 tons in 1954. Some 1,126,065 tons (1.5 per cent) were used for residential heating compared with 1,266,722 tons in 1954, continuing the decline in the amount used for this purpose.

The iron and steel industry used the bulk of the coke produced as has been the practice in the past. This industry also produces most of the coke and the coke movement follows the iron and steel industry. Most of the coke, therefore, was used near where it was produced. Pennsylvania used some 20,085,644 tons of coke which is almost the same as the 20,802,687 tons which it produced. The second largest consumer of coke was again Ohio with 13,811,223 tons and Ohio was also the second highest producer, 11,701,266 tons, and was an importer of coke to the extent of slightly over 2,000,000 tons. Indiana on the other hand, who was the third largest user of coke, used 7,720,810 tons of the 9,482,233 tons which it produced. These last two movements of coke reflect largely the movement between the plants of the United States Steel Corp., whose Chicago district and Pittsburgh and Youngstown districts are split by state lines. Since every state in the Union consumed some coke and only 21 states produced coke, there were many other movements. However, except for the states where iron was made, the movements were relatively minor.

STOCKS OF COKE AND COKING COAL

The increased business activity in 1955 reduced the available stocks of coke on hand from 2,948,840 tons at the beginning of the year to 1,700,771 tons at the end of the year. Stocks of coke at by-product plants at the end of the year included 1,460,252 tons of blast furnace coke, 47,506 tons of foundry coke, and 189,442 tons of residential heating and other coke. Stocks at beehive plants were very small at the end of the year and included 2,842 tons of blast furnace coke, 20 tons of foundry coke, and 709 tons of residential heating and other coke, for a total of 3,571 tons at the beehive ovens, or about half that at the beginning of the year. Stocks of coke breeze at the end of the year at the by-product plants totaled 759,103 tons, at beehive ovens 187 tons or a total of 759,290 tons at end of 1955 as compared with 664,085 tons on hand at end of 1954.

GROSS VALUE IN YIELD OF BY-PRODUCTS

The total gross value of by-products which were sold in 1955, exclusive of the coke breeze produced, totaled $348,379,639 which is 19 per cent higher than the $292,243,755 sold in 1954 and slightly less than one per cent over the $346,519,393 sold in 1953. The gross value of the by-products was, therefore, 28.3 per cent of the $1,221,861,621, the value of the coke produced during the year. An average of $21.92 per ton of by-product coke produced was realized for the coke, coke breeze and coke chemical materials. This includes $16.30 for the coke and $5.62 for the breeze and coke chemical materials. Coal cost per ton of by-product coke was $12.60. Coal cost per ton of beehive coke was $9.34.

In general the yields of primary coke by-products was slightly less in 1955 than in 1954. Compared with 1954, tar yield decreased from 8.46 to 8.13 gal per ton of coal, ammonia sulphate or equivalent decreased from 21.09 to 20.06 lb, crude light oil decreased from 2.98 to 2.91 gal and the surplus gas sold or used remained constant at 6.58 M cu ft per ton of coal.

GOVERNMENT TECHNICAL RESEARCH REPORTS AVAILABLE TO SCIENTISTS AND ENGINEERS

Each year over $2,500,000,000 worth of scientific and industrial research is conducted for the Federal Government, about half the total volume of research done in the United States. Each year, more and more of the results of this research are being turned over to scientists and engineers in the nation's private research laboratories and industrial plants through the work of the Office of Technical Services, U. S. Department of Commerce.

Operating under a special law passed by Congress in 1950, OTS gathers non-classified reports of research from the Army, Navy, Air Force, Atomic Energy Commission, and many other agencies of the Government, and makes them available to the public at a nominal cost to cover printing or microfilming and handling.

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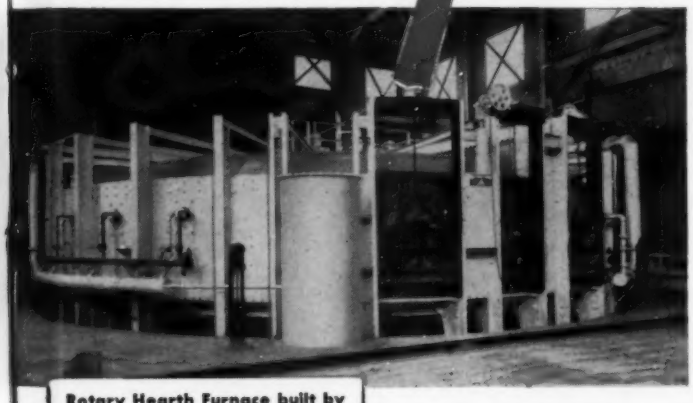

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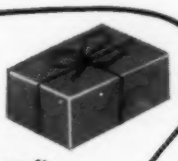

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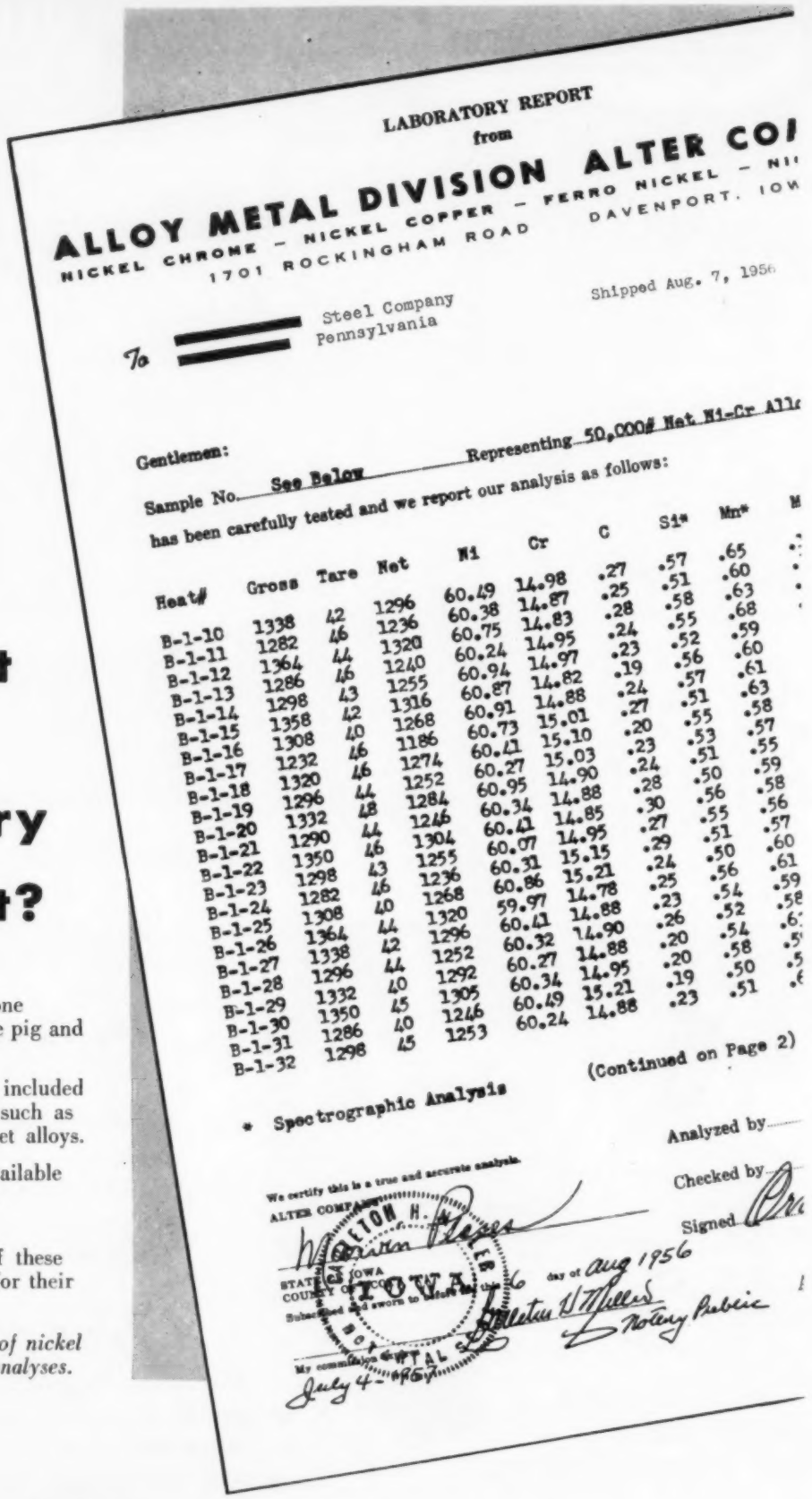

LABORATORY REPORT
from
ALLOY METAL DIVISION ALTER CO
NICKEL CHROME – NICKEL COPPER – FERRO NICKEL – NI
1701 ROCKINGHAM ROAD DAVENPORT, IOW

To Steel Company
Pennsylvania

Shipped Aug. 7, 1956

Gentlemen:

Sample No. See Below Representing 50,000# Nat. Ni-Cr Alle
has been carefully tested and we report our analysis as follows:

Heat#	Gross	Tare	Net	Ni	Cr	C	Si*	Mn*	M
B-1-10	1338	42	1296	60.49	14.98	.27	.57	.65	
B-1-11	1282	46	1236	60.38	14.87	.25	.51	.60	
B-1-12	1364	44	1320	60.75	14.83	.28	.58	.63	
B-1-13	1286	46	1240	60.24	14.95	.24	.55	.68	
B-1-14	1298	43	1255	60.94	14.97	.23	.52	.59	
B-1-15	1358	42	1316	60.87	14.82	.19	.56	.60	
B-1-16	1308	40	1268	60.91	14.88	.24	.57	.61	
B-1-17	1232	46	1186	60.73	15.01	.27	.51	.63	
B-1-18	1320	46	1274	60.41	15.10	.20	.55	.58	
B-1-19	1296	44	1252	60.27	15.03	.23	.53	.57	
B-1-20	1332	48	1284	60.95	14.90	.24	.51	.55	
B-1-21	1290	44	1246	60.34	14.88	.28	.50	.59	
B-1-22	1350	46	1304	60.41	14.85	.30	.56	.58	
B-1-23	1298	43	1255	60.07	14.95	.27	.55	.56	
B-1-24	1282	46	1236	60.31	15.15	.29	.51	.57	
B-1-25	1308	40	1268	60.86	15.21	.24	.50	.60	
B-1-26	1364	44	1320	59.97	14.78	.25	.56	.61	
B-1-27	1338	42	1296	60.41	14.88	.23	.54	.59	
B-1-28	1296	44	1252	60.32	14.90	.26	.32	.58	
B-1-29	1332	40	1292	60.27	14.88	.20	.54	.6	
B-1-30	1350	45	1305	60.34	14.95	.20	.58	.5	
B-1-31	1286	40	1246	60.49	15.21	.19	.50	.5	
B-1-32	1298	45	1253	60.24	14.88	.23	.51	.6	

(Continued on Page 2)

* Spectrographic Analysis

Analyzed by

We certify this is a true and accurate analysis.
ALTER COMPANY
Checked by
Signed

STATE OF IOWA
COUNTY OF SCOTT
Subscribed and sworn to before me this 6 day of Aug 1956
Notary Public
My commission expires July 4 1957

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High Speed Tinning Line has unique features

By J. W. BRINKS
Industry Engineering Dept.
Westinghouse Electric Corp.
East Pittsburgh, Pa.

▲ A new high-speed electrolytic tinning line at Weirton Steel Co., a division of National Steel Corp., incorporates several unique features in its electrical equipment. In operation since May 1956, the line operates at a speed of 2100 fpm.

Its 60,000-lb coils measure up to 85 in. in outside diam with a 16½ in. inside diam. To handle these very large coils this line utilizes the most powerful payoff and winding reels of any tinning line now in operation.

An idea of the size and complexity of the line can be gained from the fact that driving machines rated at 2115 hp are utilized to propel the strip through this line. The helper motors alone total about 640 hp, with the remaining portion being applied to the main drive machines.

Magnetic amplifier regulating equipment is used for all line drive regulating functions on the new line. Their inherent ruggedness and lack of moving parts make them ideally suitable for reliable operation and low maintenance. A total of 13 magnetic amplifier regulators control the drives and their supply generators on the line.

Trouble shooting in the 100-ft long controller is greatly simplified through the use of a new memory-type fault finder which instantly detects and remembers location of circuit faults. It is especially valuable to the motor room attendants in monitoring the devices in the master control circuit such as emergency stop buttons and field loss relays which may shut the line down even though open only an instant.

A total of 2400 kilowatts of radio frequency power for tin reflow can be applied to the strip in a length of only 12 ft of strip. This high power density of 200 kw per ft, coupled with the fast response scanner regulator equipment which controls the position of the flow line, works to assure that exactly the right amount of power is applied to the strip for flowing the tin. The short length under the coils and the high strip speed mean that this power is applied for the shortest possible time.

The installation of this line provides a significant increase in Weirton's tin plate capacity. The success of its installation and operation to date is a result of the effective cooperation between the Weirton Steel Co.'s engineers and operators, and the equipment suppliers and contractors.

Figure 1 (left) — Motor-mounted blowers ventilate the two 150-hp, 200/1200-rpm payoff reel drives in the left foreground and the 200-hp, 200/1200-rpm winding reel motors at the delivery end of the line.

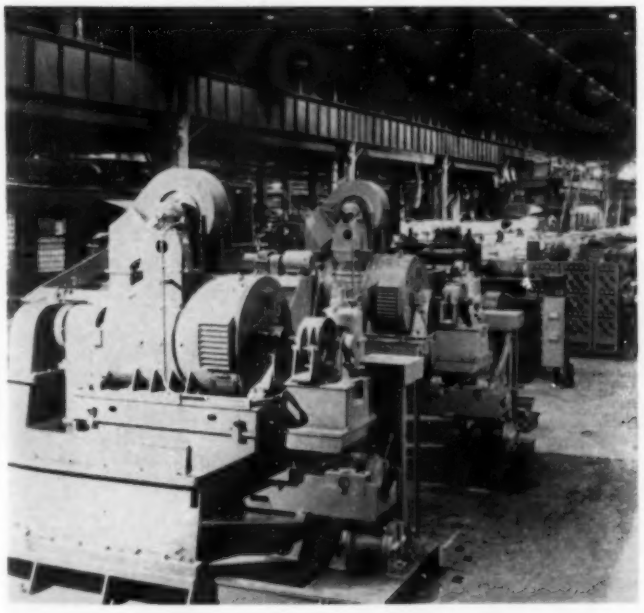
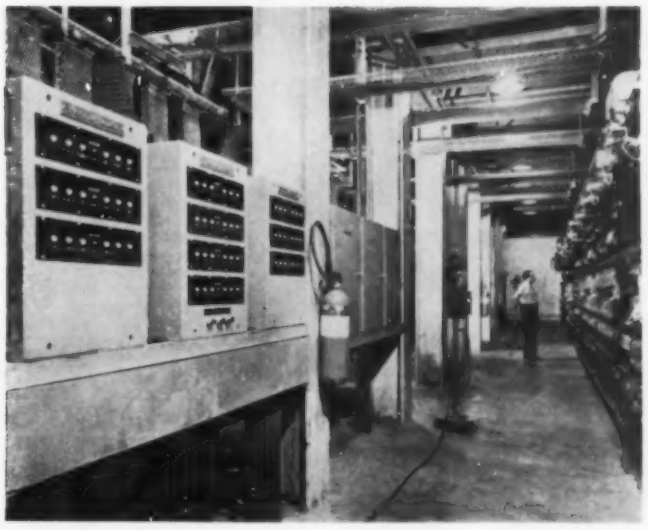


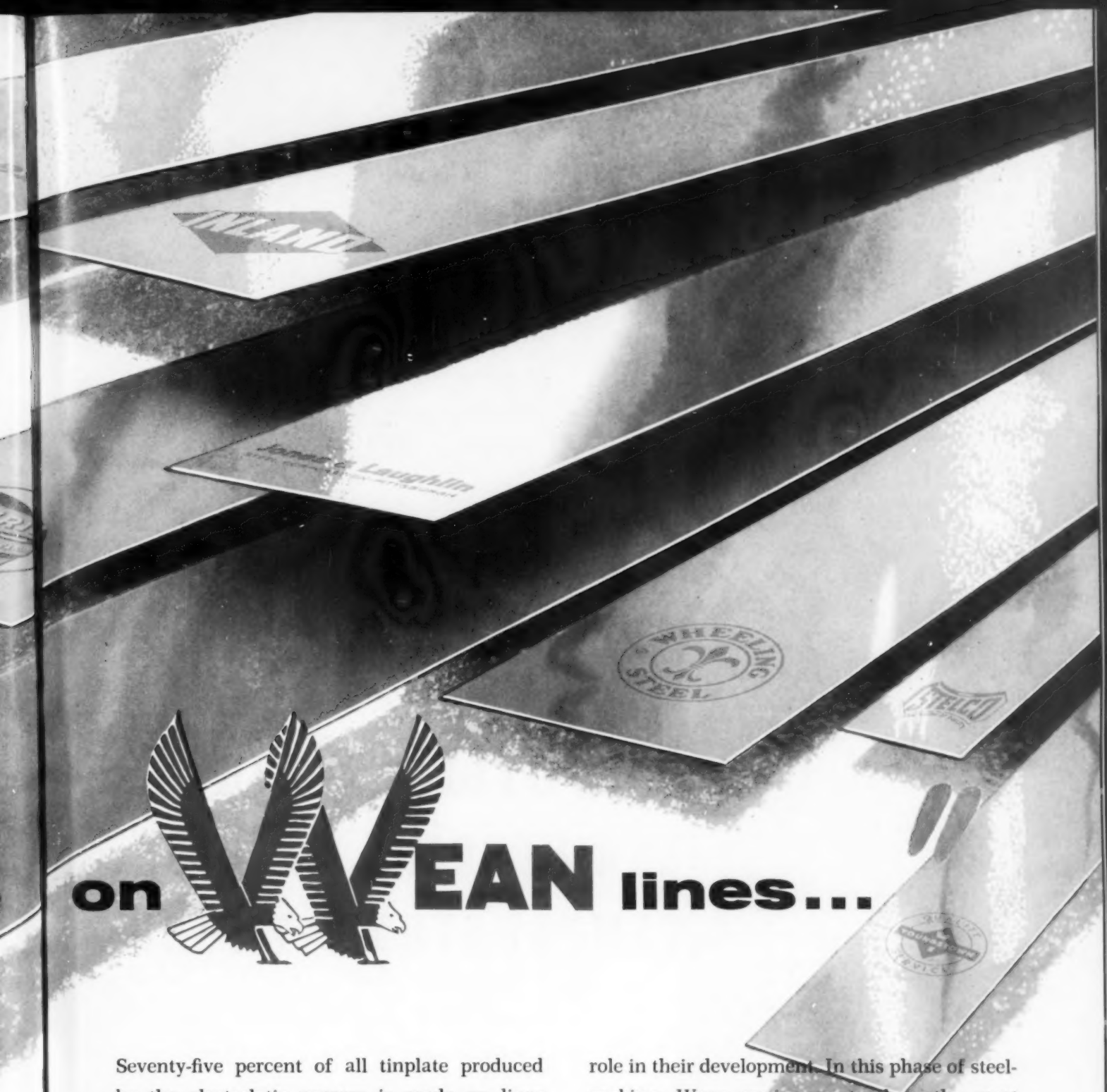
Figure 2 (right) — Cabinet mounted memory-type fault finders monitor the master control circuits for each line section.



"75%

of all electrolytic

Tinplate is made



on WEAN lines...

Seventy-five percent of all tinplate produced by the electrolytic process is made on lines bearing the Wean "Double Eagle" symbol of excellence in engineering.

This fact, itself, stands as a tribute to the ability of Wean engineers to cooperate in the creation of continuous electrolytic tinning lines that win approval of leading steel producers the world over.

The reason for such predominance: Wean helped to popularize continuous coating lines, and, through the years, has played a major role in their development. In this phase of steel-making, Wean engineers stand as the most experienced group of their kind ever assembled.

And, because these engineers are constantly searching for means to achieve even greater line efficiency, you can be certain of the finest, most advanced coating equipment available any time you assign Wean to the job.

9957

The WEAN ENGINEERING CO., Inc.
Warren, Ohio

▲ HIGH temperature process piping systems and power plant piping systems used by the steel industry and other industries are posing some of the most complex problems that mechanical engineers are called upon to solve. The sole reason for this complexity is the expansion of metals with rising temperatures under increasingly high temperature and pressure conditions of use.

Economical maintenance of the piping and associated equipment, and the safety of such piping systems depend upon proper solution of these problems, which until recently required methods that are extremely time consuming.

Pipe expands more than nine in. in a hundred ft when the temperature is elevated to 1000 F or higher and pressures are 2000 psi. These are now common operating conditions. Such expansion would put destructive forces and stresses on the pipe and associated equipment if the piping system were not designed to be flexible so that there will be no concentration of stress at any point.

Proper provisions for safe distribution of thermal stresses in piping have taken skilled stress analysts as long as a month or more to complete complex design computations in order to satisfy all code requirements. These computations are almost completely independent of heat expansion problems in the design of equipment which the piping serves, i.e., the boilers, turbines, heat exchangers, process equipment, etc.

Now, Blaw-Knox Co.'s Power Piping Division, Pittsburgh, has a new method of making design computations that eliminates delays by taking advantage of the high accuracy and speed of electronic computers, as shown in Figure 1. With this automatic method it is possible to complete computations within a single working day. The method is available for use by consulting engineers and to companies and individuals responsible for the design of power piping systems.

The automation of these engineering problems was accomplished recently in an 18-month joint research project of the Power Piping Division with Arthur D. Little, Inc. This fact makes it evident that the availability of electronic computers for solving complex mathematical problems often does not offer immediate means of solving problems of this type advantageously. In this instance, since the existing "classical approach" was not well adapted to these machines, basic principles of stress calculations were re-examined in order to obtain results quickly and accurately by electronic computation.

The new method used by Blaw-Knox is important not only for its great time savings in completion of plant design but also as a contribution in the conservation of engineering manpower. It is an advancement in the art of using an electronic computer for practical problems of this type as well as a fundamental contribution in mathematics and pure mechanics. Although Blaw-Knox is not the first to use an electronic computer for this purpose, its method, known as the "6 x 6" Flexibility Matrix Method, is an outstanding improvement because of the simplicity, speed, and the high accuracy that are obtained with it.

The data that are fed into the machine consist only of dimensions that can be taken easily from an isometric drawing of the piping sys-

Figure 1 — Actual computations for designing a complete high temperature piping system take less than an hour on the electronic computer. During this time, the operator (left) is alert to signals on the control console indicating erratic operation, which may be induced by peculiarities of the problem or by other factors.

COMPUTERS SPEED ENGINEERING OF HIGH TEMPERATURE PIPING

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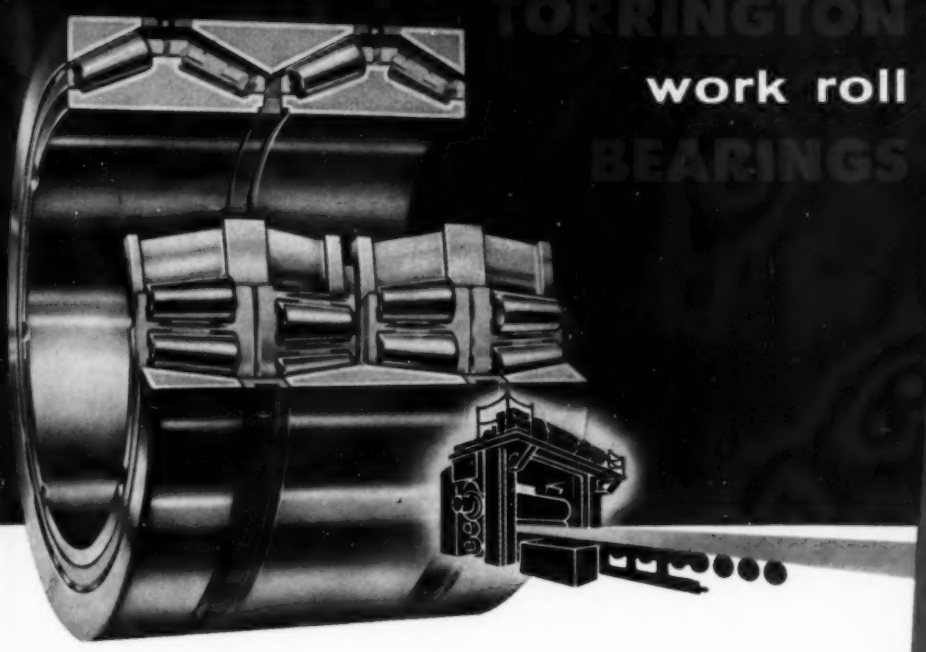

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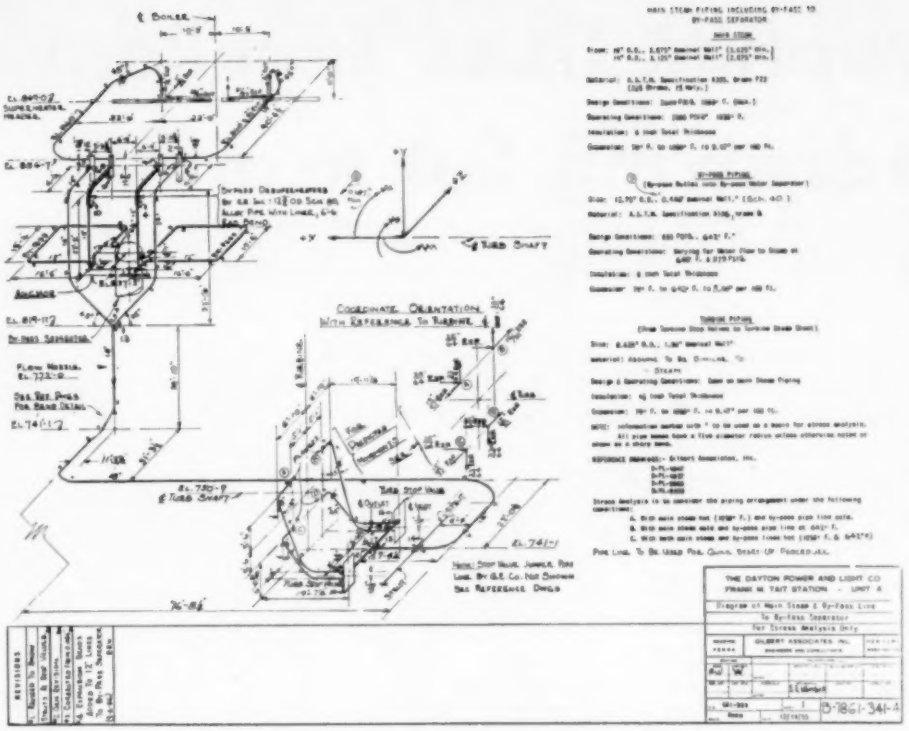


Figure 2 — Flexibility analysis of this 8-anchor steam piping system was completed in an hour by electronic computer. The system will be used at the Frank M. Tait Station of The Dayton Power and Light Co.

tem, such as that illustrated in Figure 2, and a few physical properties of the pipe material. These data are first tabulated on simple forms from which the figures can be fed readily onto a suitable input medium such as magnetic tape. The actual machine part of the computation takes less than an hour. The total time required includes that for putting the data on tape, checking the accuracy of a printed transcription, putting the tape through the computer, and for a machine transcription of the computed results that are obtained on output tape, into orderly tabular figures. Table 1 shows the first of five pages of results for the system illustrated.

The high accuracy of computations is indicated by the fact that all results are carried to six significant figures. Inconsistencies in the input data are detected by the machine which will inform the operator of the error and, if permitted, will substitute the correct dimension automatically. Accuracy is limited only by the accuracy of the input data. No short-cut approximations are made because all complicating factors and special variables can be taken fully into account.

Piping system complexity is unlimited. Any number of anchors and restraints can be included. Out-of-plane bends as well as restraints are routine. The number of free ends and junctions has no effect on the accuracy or efficiency of machine analysis. Floating headers, with the resulting calculations naturally proceeding back through the superheater tubes to the boiler restraints, are taken into account. Also all of these factors can be taken into account in looped systems in which steam flow passes from a single pipe into two pipes and then into a single pipe again. The latest experimental and theoretical results on flattening of bends caused by in-plane and out-of-plane bending are also included in computations.

Only mathematicians can appreciate the fact that a serious accuracy limitation of the former "classical approach" which requires "inversion of larger matrices" was overcome by introducing a method that employs 6 x 6 matrices throughout. However, anyone can appreciate that one important advantage arising from the new method, beyond the original objectives, is that in the process of designing a piping system, when it is necessary to change one component, the additional calculation is confined to this member instead of requiring, as before, a complete re-calculation of the whole system. Intermediate calculation, obtained earlier for the unchanged part of the system, can now be used again.

These achievements in speed and accuracy mean tremendous savings in ultimate costs, primarily indirect costs attributable to the importance of time savings which are even more important than the reduction of engineering costs of computation. The latter, though they may be considerably less than former costs, are but a small fraction of the total cost of a high temperature piping system. The importance of the new method from the standpoint of cost is largely to be derived from time savings in completing the design of a piping system and thereby, the power plant or processing plant in which it will be used.

Blaw-Knox can now test a proposed system of high temperature piping before bidding on the job.

TABLE 1

BLAW-KNOX CO.-POWER PIPING & SPRINKLER DIVISION — PAGE #1

STRESS ANALYSIS - THE DAYTON POWER & LIGHT CO, FRANK M. TAIT STATION - Unit #4

MAIN STEAM - CONDITION #3 - (MAIN STEAM & BY-PASS HOT) - (PER DWG, B-7861-341 SHT.#1 - REV, #6) PREPARED FOR GILBERT ASSOCIATES INC. — 9-18-56

SECTION	MEMBER	FX LBS	FY LBS	FZ LBS	MX IN-LBS	MY IN-LBS	MZ IN-LBS	DX INS	DY INS	DZ INS	RX RADS	RY RADS	RZ RADS	MX PSI
933mx3x 01	0	-46	-991	-1458	-147196	-30749	-45896	-0.956	0.012	0.216	0.0000	0.0000	0.0000	429
933mx3x 01	1	-46	-991	-1458	-103826	-30749	-57796	-0.971	0.151	0.324	0.0001	0.0000	0.0000	518
933mx3x 01	2	-46	-991	-1458	43421	30658	-108143	-1.373	1.106	-0.145	0.0000	0.0000	0.0000	563
933mx3x 01	3	-46	-991	-1458	117813	137368	-193965	-1.107	1.087	-0.704	0.0000	-0.0000	0.0000	1055
933mx3x 01	4	-46	-991	-1458	166493	159916	-210874	-2.091	1.074	-1.077	-0.0000	-0.0000	0.0000	1409
933mx3x 01	5	-46	-991	-1458	190197	143697	-210874	-1.946	0.911	-3.027	-0.0014	-0.0000	0.0001	1774
933mx3x 01	6	-46	-991	-1458	178747	68630	-167464	-1.330	0.910	-3.301	-0.0006	-0.0011	0.0007	1651
933mx3x 01	7	-46	-991	-1458	178747	-69306	-64332	-0.704	1.130	-3.429	-0.0003	-0.0011	0.0008	1999
933mx3x 01 REFERENCE		-0	-0	0	-0	-0	0	-0.704	1.130	-3.429	-0.0003	-0.0011	0.0008	0
933mx3x 02	0	421	109	-1001	236430	-19013	130179	-0.704	1.130	-3.429	-0.0003	-0.0011	0.0008	1178
933mx3x 02	1	421	109	-1001	209866	-69979	115250	-0.173	1.179	-3.446	-0.0003	-0.0011	0.0008	1149
933mx3x 03	0	421	109	-1001	209866	-69979	115250	-0.173	1.179	-3.446	-0.0003	-0.0011	0.0008	1079
933mx3x 03	1	421	109	-1001	207774	-64388	114891	-0.152	1.135	-3.405	-0.0027	-0.0040	0.0027	1060
933mx3x 03	2	421	109	-1001	151113	-38827	85385	0.038	0.663	-3.456	-0.0030	-0.0035	0.0015	1249
933mx3x 04	0	421	109	-1001	151113	-38827	85385	0.038	0.663	-3.456	-0.0030	-0.0035	0.0015	1249
933mx3x 04	1	421	109	-1001	-31196	-38827	8301	0.332	-0.312	-0.113	-0.0070	0.0020	0.0005	1981
933mx3x 04	2	421	109	-1001	-47861	-39524	1117	0.343	-0.343	-1.912	-0.0061	0.0009	0.0007	2343
933mx3x 04	3	421	109	-1001	-45950	-89173	3085	0.910	-0.183	-1.887	-0.0050	0.0040	0.0010	3096
933mx3x 04	4	421	109	-1001	-45950	130958	80799	-0.681	-0.364	-1.938	-0.0061	0.0010	0.0008	6090
933mx3x 04	5	421	109	-1001	-43393	143569	82983	-0.586	-0.387	-1.661	-0.0035	-0.0020	0.0008	6630
933mx3x 04	6	421	109	-1001	-47146	81190	82983	-1.230	0.196	-0.836	-0.0029	-0.0052	0.0000	4960
933mx3x 04	7	421	109	-1001	-31178	55975	80799	-1.364	0.343	-0.639	-0.0020	-0.0010	-0.0004	3451
933mx3x 04	8	421	109	-1001	-31178	-108302	3085	-0.590	0.178	0.500	-0.0016	-0.0064	-0.0005	6191
933mx3x 04	9	421	109	-1001	-47146 ;	-117949	1117	-0.431 ;	0.130	0.586	-0.0010	-0.0033	-0.0005	6909
933mx3x 04	10	421	109	-1001	-41194	-43006	1117	-0.098	0.008	0.061	-0.0007	-0.0019	-0.0002	4303

Colloidal Graphite Does Excellent Job as Wiredrawing Lubricant

▲ THE demand for more and better wire products in our modern economy has resulted in continually increasing production of all existing types of wire. Moreover, tough, new alloys present unfamiliar production difficulties to the wiremaker, but improved dies and lubricants help to overcome these problems as they arise.

Varying physical properties of the many types of wire metal demand a wide range of operating procedures to obtain maximum practical ductility for the drawing operation along with specified characteristics in the finished wire. Thus, some wire is drawn cold, some hot; some wire is reduced only slightly by a pass through the die and must be heat-treated between draws; some can be brought down to final dimensions in a single die directly from rod or coil form; some wire is drawn with no die lubricant, some with liquid lubricant, some with quasi-liquid lubricant, and some with dry lubricant.

Broadly speaking, there are two basic methods of drawing wire: the dry process and the wet process. In a typical dry-drawing operation, the rod or wire is acid-cleaned, coated with slaked lime, baked, and drawn dry through a grease or soap compound in the lubricant box and into the die. (A variation of this procedure utilizes soluble oils in the box for an otherwise dry operation.) In one wet-drawing method, stock is plated by immersion in copper sulphate solution, then placed in a vat of fermented meal/yeast liquor from which it is drawn directly, the liquid serving to lubricate the die.

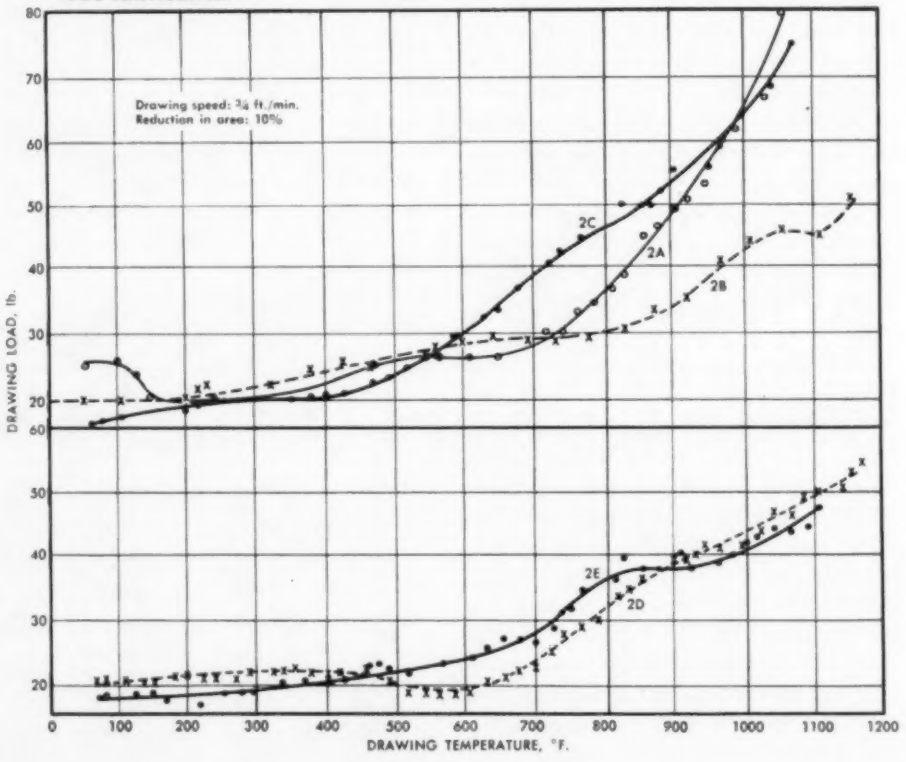
Soft, ductile wire, like some copper or aluminum stock, is occasionally drawn cold with no lubricant at all. This is made possible by the use of proper die materials, well designed dies, and favorable drawing speeds.

Exceptionally tough wire, such as stainless steel, is sometimes coated with copper, sometimes with tin or lead, to provide surface ductility in wet-drawing operations. Aluminum wire and fine sizes of ferrous wire are usually drawn with the help of compounded oils. Soluble oils or paste compositions of soap/fat mixtures are often used for larger gages of ferrous wire and for copper and brass wire in high-speed, continuous drawing. Grease alone, put inside the lubricant box of dry-drawing machines, gives especially bright, clean finishes, where these are required.

Extremely fine sizes of tungsten and molybdenum wire can be drawn succesfully in production only when coated with a water dispersion of colloidal graphite and heated to leave a dry lubricating film on the wire surface. About 40 years ago, the first tungsten filaments for electric lamps were drawn successfully with the use of 'aquadag' ('dag' colloidal graphite in water). Today this same process is still being used for the very finest grades and sizes of filament wire. The wire runs first through a "fountain" of diluted aquadag. This coats the surface with water-dispersed colloidal graphite. Heating dries the coating and raises the temperature of the wire to obtain optimum ductility. Colloidal graphite is one of few substances that will adhere to wire at red heat. The "graphoid" film, formed by the graphited wire being drawn through the diamond die, permits continuous low-load drawing and greatly lengthens die life. Many other lubricants have been tested over the years, but nothing else has yet been found practical for this critical application.

Drawing of steel wire is the most

Figure 1 — Load-temperature curves for drawing mild-steel wire with various lubricants.



Lubricants

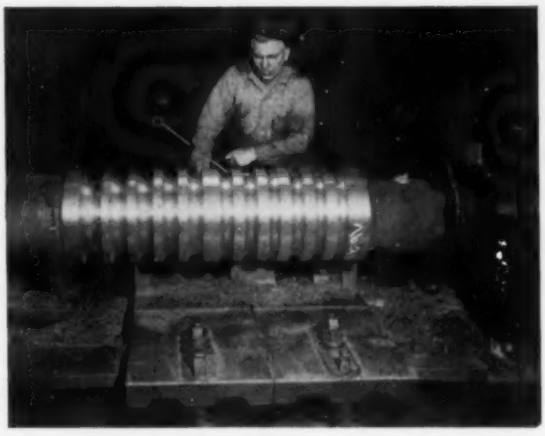
- ● A. 'Aquadag' (colloidal graphite in water) diluted with 2 parts water + wetting agent.
- x B. 'Prodag' (semi-colloidal graphite in water) diluted with equal amount of water + wetting agent.
- ● C. 'dag' Dispersion No. 226 (semi-colloidal graphite in water) + wetting agent
- x D. 'dag' Dispersion No. 2404 (colloidal graphite in mineral spirits).
- ● E 'dag' Dispersion No. 2412 (semi-colloidal graphite in mineral spirits).

TIPS FROM A ROLL MAKER'S NOTEBOOK

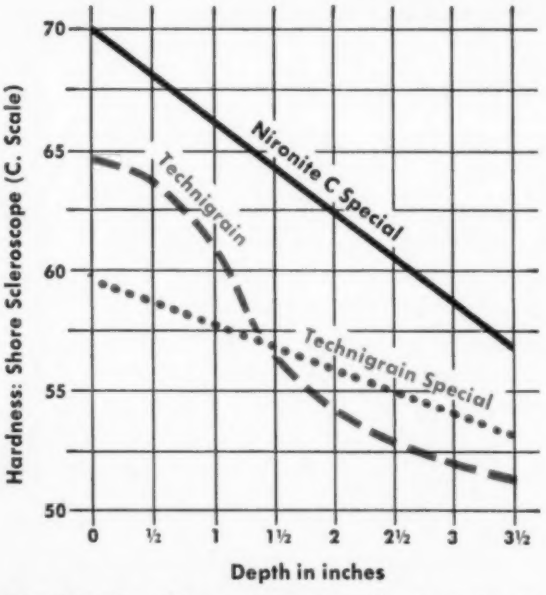
MACKINTOSH-HEMPHILL DIVISION, E. W. BLISS COMPANY, Pittsburgh 3, Pennsylvania

Cast mill rolls • Johnston cinder pots • rotary tube straighteners • end-thrust bearings • heavy-duty lathes • steel and special alloy castings

A merchant mill roll should be just good enough



Easy to turn: Mack-Hemp *Technigrain* and *Technigrain Special* rolls are readily turned and redressed.



Technigrain rolls compare favorably in hardness penetration with more expensive, higher-alloy types, as shown by these generalized curves.

The wise purchaser of merchant mill rolls buys rolls that give him the service life he needs *and no more.*

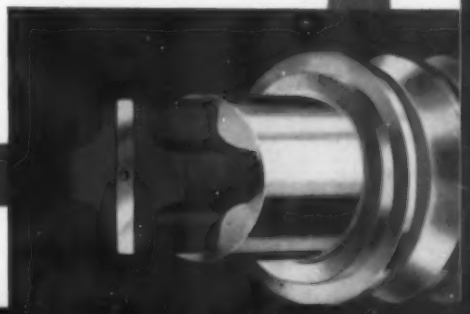
This is because increased roll service life usually goes hand in hand with higher alloy content and more complex heat treatment. Both add to the price of the rolls. But... most merchant mill operators redress their rolls after each production run. Thus, if a set of rolls is still good for more tonnage before redressing at the end of a run, chances are that the rolls are too good—and therefore too expensive—for the job.

But price is not the only consideration. To be just "right", a merchant mill roll should (1) offer wearing qualities closely related to the length of the production runs for which it is used; (2) have good hardness penetration to provide wear resistance at the bottom of passes; and (3) have grain structure fine enough to assure good finish of the rolled product.

Quality at low price. Mack-Hemp *Technigrain* and *Technigrain* Special rolls offer an inexpensive solution. In fact, *Technigrain* rolls are so generally useful for all merchant shapes that they have virtually eliminated the roll inventory problem for many operators. At a price that averages several cents per pound less than higher-alloy grain rolls, *Technigrain* and *Technigrain Special* provide service life adequate for the vast majority of applications. Available in a hardness range of 55 to 60 Shore (C Scale), they offer good hardness penetration and finely dispersed graphite to provide a smooth work surface. Of course, for unusually severe merchant mill service, Mack-Hemp's *Nironite C Special* offers all of Technigrain's properties, in a higher hardness range.

To sum up, *Technigrain* is the ideal roll for general merchant mill use: it is low in cost, it provides sufficient service between redressings, and it rolls products of better-than-adequate surface finish.

Technigrain is only one of the more than thirty types and hundreds of iron and steel roll analyses produced by Mack-Hemp. For advice and information relating to your specific roll application, why not 'phone or write us today? There's no obligation. Address Mackintosh-Hemphill Division, E. W. Bliss Co., Pittsburgh 3, Pa.



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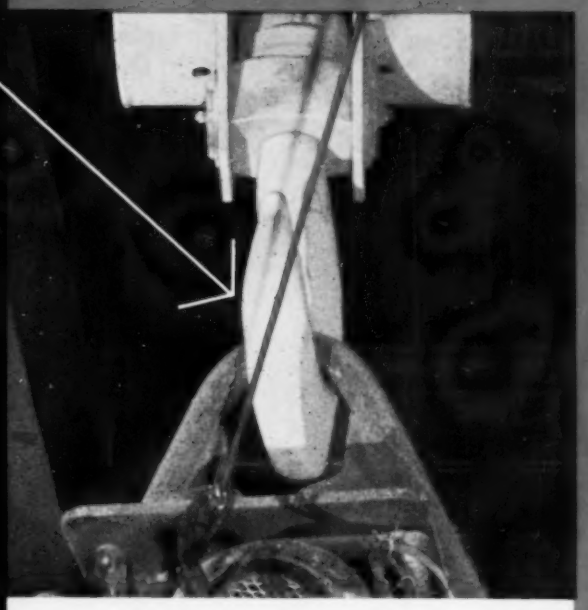

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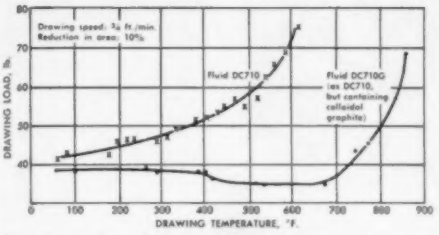

Drawing speed: ¼ ft./min.
Reduction in area: 10%
Fluid DC710
Fluid DC710G (as DC710, but containing colloidal graphite)
DRAWING LOAD, lb.
DRAWING TEMPERATURE, °F.

Figure 2 — Load-temperature curves for drawing mild-steel wire lubricated with silicone fluids.

important today in terms of volume, variety, and value of goods produced. In this field, both high-carbon and low-carbon steels are pretreated with 'prodag' (semi-colloidal graphite in water) by immersing the rods or coil stock in a diluted mixture of prodag and water, to which wetting agent is usually added, and then baked in a 200 F oven to dry the graphite film. The stock is drawn dry, and the single pre-coat often lasts through several consecutive reductions. In a typical case, production of as much as 200,000 pass-pounds through 90 gal of diluted mixture has been regularly accomplished, with no graphite visible on the finished wire.

A considerable amount of work has been done recently on the effects of a wide range of lubricants in the hot-drawing of steel wire. In this operation, lubrication is the essential problem. Tests on both dead-loaded and live machines have pointed up the inestimable value of colloidal and semi-colloidal graphite for this process.

Several graphited drawing-lubricants were evaluated including the following standard dispersions: aquadag, prodag, dag dispersion No. 226 (another semi-colloidal graphite in water), and dag dispersion No. 2404 (colloidal graphite in mineral spirits). Stock being drawn was bright-annealed, mild-steel wire of 0.0475-in. original diameter, pointed first and then degreased by hand with benzene on a pad of cotton. New (only having been "run-in") tungsten carbide dies with a slight radial taper (semiangle, 5 degrees) were used. Draws produced an area-reduction in the wire of 10 per cent, at a speed of 3.4 fpm, at temperatures ranging from ambient to more than 1150 F. Drawing speeds were deliberately low, since a successful lubricant may be expected to behave even better at higher speeds.

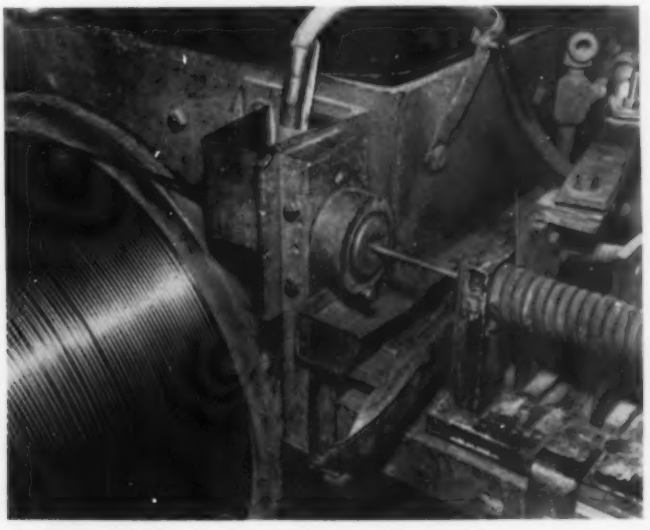
Aquadag, diluted 2:1 in water plus wetting agent, gave a smooth draw at temperatures higher than 900 F, although the drawing load began to increase considerably at temperatures above 700 F. Prodag, thinned 1:1 with water (with 2 per cent by volume of wetting agent added), permitted entirely smooth drawing as high as 1100 F. Dag dispersion No. 226 plus wetting agent provided consistently satisfactory results. Colloidal graphite in volatile carriers has shown exceptional promise. Dispersions in benzene and in alcohol performed very well. Graphite in mineral spirits was outstanding, the semi-colloidal form, represented by dag dispersion No. 2412, showing up best of all (Figure 1).

Under conditions of hot-drawing, temperature stability of the lubricants involved is a major factor in their successful action. Basically these lubricants are of two types: those susceptible to heat and those resistant to heat. All substances are altered by thermal conditions, and most lubricants are greatly affected within the heat ranges involved in wiredrawing operations. Oils or greases thin out as temperatures rise; this, alone, changes their lubricating value considerably. At some critical temperature, organic boundry-lubricant films volatilize or decompose, resulting in greatly reduced lubricity. This point is reached when the drawing load increases sharply. In the case of lubricants consisting of a mixture of substances, each with its own temperature of volatilization or decomposition, drawing load ordinarily will increase in a series of steps.

Graphite, however, is to all practical purposes inert under conditions met in drawing practice. When graphite dispersions are used in cold-drawing, the liquid carrier may evaporate at the die face. In hot-drawing, the carrier is always driven off well before the wire reaches the die. In either case, the graphite coating alone provides the necessary lubrication. Whenever graphite dispersions are used, the liquid vehicle need serve only to distribute the solid lubricant effectively on the wire surface, and the graphoid film produced by high surface pressure in the die provides lubrication for the draw. In some cases lubrication actually gets better as temperatures are raised.

Figure 3 — Three-stand, high-speed, flat wire rolling mill operates at speeds up to 2000 fpm, producing 1000-lb reels of finished wire, compared with a previous maximum of 250 lb.

Figure 4 — After passing through heater element (right) the wire is coated with a dispersion of semi-colloidal graphite and water in preparation for the succeeding draw. It is then coiled on a power driven reel which provides the tension necessary to draw the wire.



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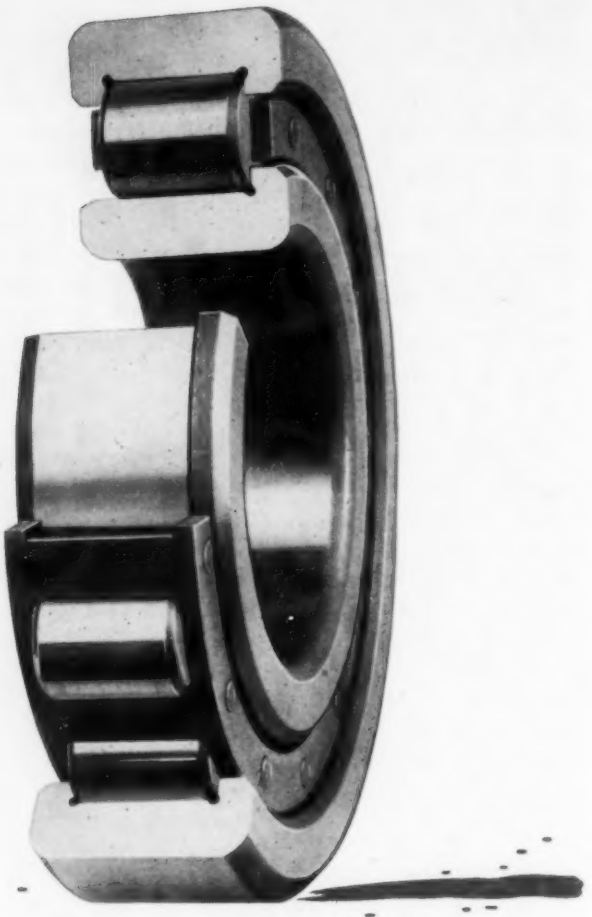

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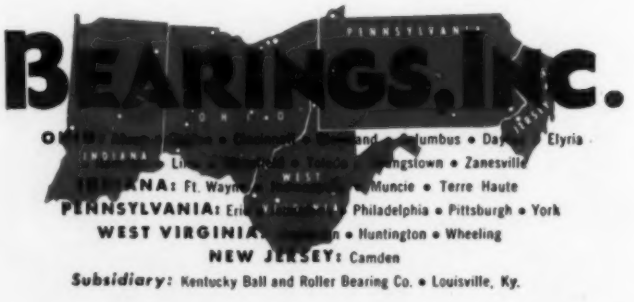
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Further tests, run with silicone lubricants, demonstrated these advantages of dag dispersions most dramatically (Figure 2). A commercially available silicone fluid, DC710, gave adequate lubrication up to its flash point (approximately 610 F); beyond this, drawing was impossible. On the other hand, a companion product (silicone fluid DC710G), differing only in that it contains 5 per cent 'dag' semi-colloidal graphite, permitted drawing at temperatures above 850 F. It can be seen, too, how the drawing load, between 400 and 700 F with the graphited silicone, is consistently below that recorded at lower temperatures.

Chemically deposited copper coatings on steel wire are very satisfactory when drawn wet. In testing dry-drawing of such coatings, they were found to peel off, and above 300 F they oxidize and score the dies. However, when copper is deposited electrolytically on a colloidal graphite undercoating, promising results are obtained—further work along this line may be undertaken later on.

Another prime industrial need today is for copper and copper-alloy wire. The continually growing market has put severe demands upon wire manufacturers to increase production quickly and economically. The best way to do this is to increase drawing speeds on existing equipment. Work in this direction has led several prominent manufacturers to test exhaustively the effectiveness of adding colloidal graphite to their drawing compounds. Results have been so favorable that graphited lubricants are now standard in many plants.

One typical case is that of a company producing a variety of brass and bronze wire. Here, a low-brass wire was to be drawn to one-ninth of its original cross-sectional area—from 0.092-in. diam to 0.032-in. The wiredrawing equipment employed in this operation used eight dies per machine, and a speed of 2000 fpm was desired. The first of the eight dies in the series reduced wire diameter from 0.092 to 0.085 in. and wore very rapidly. Only three spools, of 300 lb each, could be drawn before breakage occurred. This die showed consistent "ringing" or excessive wear at initial point of pressure.

It was recommended that 2 per cent by weight, of aquadag be used in undiluted soluble soap. A special box was made to contain this paste lubricant, and the wire was drawn through the mixture before entering the first die. Immediately die life was increased ten-fold, permitting uninterrupted drawing of at least 30 spools. Continued high production of this wire has verified these results, and has definitely proven them to be due entirely to the incorporation of aquadag as described above.

As a result of the success on this job, it was decided to standardize on 'dag' colloidal graphite for all the drawing machines in the plant. To accomplish this, an initial charge of 24 lb of aquadag was added to the central reservoir, which contains 2000 gal of soluble soap solution. This formulation (a 0.15 per cent dilution of aquadag) has been in use ever since for drawing all types of wire produced at the plant—bright annealed alloys of brass, bronze, and nickel. Reductions down to 0.028-in. diam are made at speeds of 800 to 2000 fpm, depending upon alloy and gage. Make-up lubricant is added as necessary.

The colloidal graphite cannot be detected on this drawn wire. The microscopic and sub-microscopic particles of graphite remain permanently suspended in the drawing compound, and the dimensionless graphoid film produced on the die surface, as well as on the wire, furnishes superior lubrication and prolongs die life far beyond normal expectations.

As the need for improved lubrication continues to increase in all types of metal forming, colloidal graphite can contribute its unique combination of properties to assure successful operations. Ease of application, chemical stability, high lubricating value, reduced metal pickup, longer tool or die life—these are only a few of the many advantages provided by this versatile and valuable material.

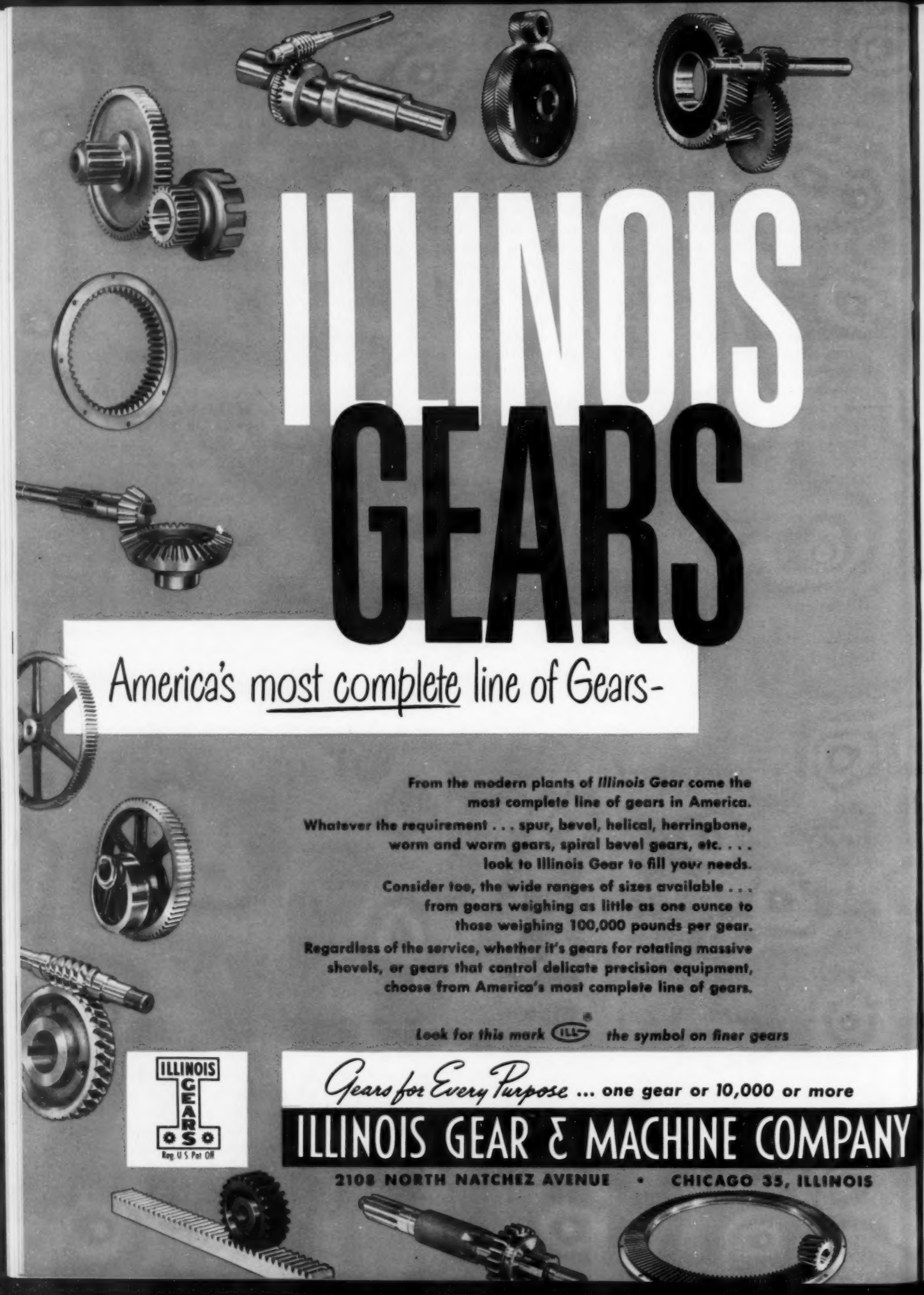
Low Temperatures and Longer Immersion Times Reduce Pulling

▲ Acid consumption in the pickling of continuous welded pipe was reduced to 13.9 lb of 66° Be′ sulphuric acid per ton in a test conducted at the Etna, Pa., plant of National Supply Co. recently by John L. Collins, superintendent of galvanizing. These results were reported Oct. 26 at the 35th meeting of the American Zinc Institute in Hamilton, Ontario, by Mr. Collins, who is chairman, Pipe Section Galvanizers' Committee of the institute.

Mr. Collins discussed the advantages of low temperature pickling and concluded that the investment in extra tanks to permit longer pickling periods would be more than justified in better pickling, greater savings in acid, and still greater savings in costs of disposal of waste acid.

In reviewing his past efforts to reduce pickling costs, he pointed out that no changes have been made in inhibitors or acids and no radical change in practice. Improvements resulted from the training of picklers and elimination of their wasteful habits. Waste pickle liquor disposal costs have been greatly increased by the adoption of methods which reduce pollution of streams, he said.

Several major considerations in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the pickling capacity of sulphuric acid were discussed by Mr. Collins. First was the importance of slow pickling at low temperatures. This prevents excessive solution of iron and slows reduction of acid concentration. It may require more pickling tanks to meet requirements of the galvanizing kettle. The number of tanks can be reduced by the use of rocker type tanks in which pipe is constantly moved in and out of the acid. Pickling tanks of this type will replace the remaining still tanks at National Supply Co. and thus reduce the total number of tanks from five to four when present plans are consummated.

The test was kept under control starting with a new solution of 2824 gal of acid in one tank from the rocker type pickler. Concentration was 7.58 per cent by volume of 66° Be′ sulphuric acid. Three quarts of a popular brand of inhibitor were used to retard the solution of the steel in the acid. Solution temperature was 75 F at the start of pickling and the total time in use for pickling was 100 hr and 24 min. Total quantity of acid used was 3190 lb, and the total tonnage of pipe pickled in the test was 228.3 tons.

Some lifts required longer pickling than others because of stubborn layers of scale inside a few lengths of pipe. Solution temperature was raised to 122 F and the number of pickling tanks was increased in order to maintain flow to the galvanizing kettle without wasting acid.

Former practice was to give the tank another charge of acid as well as increase of temperature. As a result iron concentration would gradually build up to about 6 to 7 per cent where pickling would be difficult and the tank would have to be discharged, thus wasting 500 to 600 lb of 66° Be′ sulphuric acid.

Another waste of acid resulted from storing pickled pipe under water in rinse tanks. Some waters, especially raw river water which has a high oxygen content, cause formation of a layer of iron oxide which is difficult to remove. This is especially troublesome and wasteful of acid with small sizes of pipe because of reduced circulation of acid. Dry storage of pickled pipe while waiting to be galvanized was recommended for this reason.

Tests results showed that the greatest reduction in acid occurred during the pickling of smaller sizes. At the same time the increase in iron content was relatively large because of the larger area of pipe surface exposed to the acid. Nearing the end of the test the drop in acid concentration was slow because the pipe was being removed for galvanizing shortly after the scale was removed. This meant that each lift was being inspected closely so that new lifts could be started as soon as possible. As the final lift was removed from the acid, the formation of iron sulphate on the pipe was considerable and at least three hours of pickling at 150 F was required. The test was terminated because the time was too long for operating purposes and the iron content was approaching 5 per cent.

The addition of acid in pickling tanks when iron concentrations are 5 per cent or more results in higher drosses. High iron content of the flux tank is invariably caused by dragout of pickling solutions high in iron. Thus pickling becomes slow and extremely high temperature is required to remove scale. A large amount of iron sulphate crystallizes on the pipe when removed from such solutions. Some of this salt is oxidized to the ferric state in the atmosphere and cannot be removed in the rinse tank. These salts, in addition to the ferrous salts that are carried over to the flux tank, can account for as much as 50 per cent of the dross produced, even under the most ideal rinsing conditions.

Efficient use of acid can only be realized by constant attention and analytical control. Tests indicated that pickling at longer intervals with low temperatures will permit a greater saving in acid as well as an additional economy in disposing of waste acid.

The cost of the acid and inhibitor used in this test was approximately $38 and the cost of hauling the waste acid was about $56. The total of $94 for 228.3 tons of pipe pickled is equivalent to 41 cents per ton. If acid consumption for the same amount of work approached 40 lb of acid per ton of pipe, the cost might be as much as $1 per ton or even more.

The increase in volume of the pickling solution from live steam used for heating was 235 gal. Although this dilution could be prevented by the use of heating coils, longer periods of time would have been necessary to raise the temperature. Use of 150-psi steam in open jets increases temperature of large volumes of solution rapidly, but will cause rapid corrosion if used in coils for heat transfer in pickling acids, even if coils are made of acid resisting materials. Open jets were used because the problem of dilution was small and did not add appreciably to the cost.

Other advantages also result from low temperature pickling. One is the absence of corrosive fumes. This is beneficial to both personnel and equipment, especially when cold weather reduces ventilation. Second, the low hydrogen absorption that results from low temperature pickling contributes to the production of ductile coatings. The gaseous hydrogen that is absorbed in the steel during pickling tends to evolve through the zinc coating as pipe are withdrawn from the molten zinc. Minute craters are produced at the points of evolution and the coating is susceptible to rupture at these points when coatings of high ductility are required.

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There is a constant demand for copies of "The Modern Strip Mill", published by the Association of Iron and Steel Engineers. If your copy is not in use please get in touch with us.

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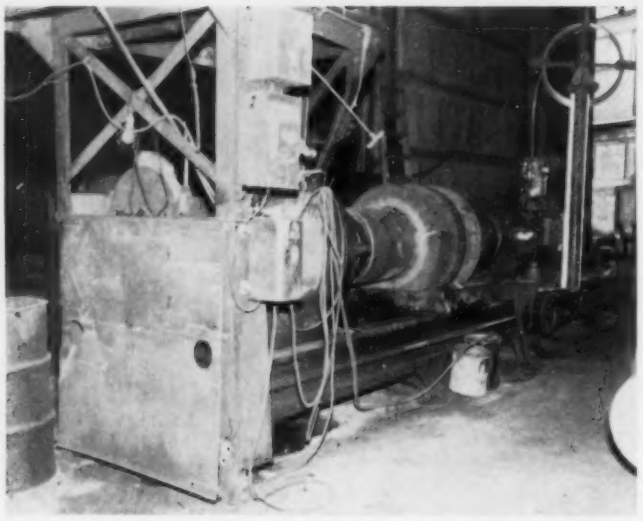


Figure 1 — Lathe setup was adapted by Fort Pitt Bridge Works to do build-up work on worn rolls by submerged arc welding. An automatic head and coil of electrode wire are mounted on the lathe carriage which is traversed as required to lay down a continuous bead on the surface to be built up.

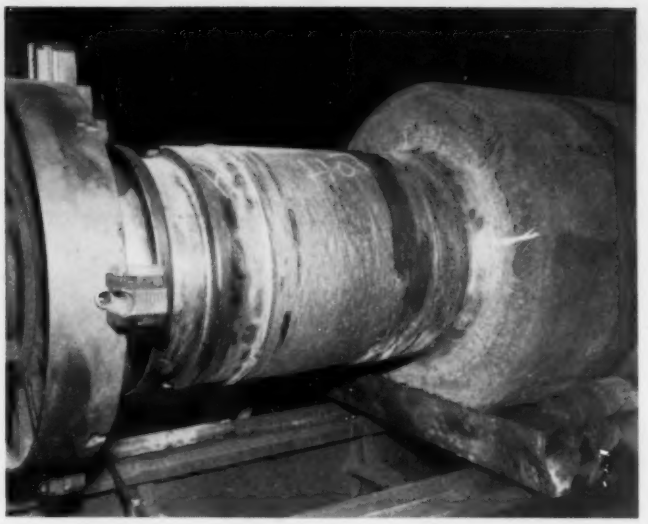


Figure 2 — Close-up of a roll whose cylindrical surface (of the smaller diameter) has been built up by arc welding, as the roll is rotated slowly and an automatic welding head mounted on the lathe carriage is traversed to produce a continuous bead.

CONVERTED LATHE BUILDS UP WORN ROLLS

By ROBERT HALL

District Engineer, The Lincoln Electric Co., Cleveland, Ohio

▲ ARC welding of several types is done on a large variety of jobs at the Fort Pitt Bridge Works plant at Canonsburg, Pa. Much of it is on heavy structures, but the company has installed a well-planned setup in which steel rolls, especially of types used in steel mills, are built up or resurfaced by arc welding.

As Figure 1 indicates, an old long bed lathe is employed to support and rotate the rolls, as an automatic arc welding head, supported on the lathe carriage, is advanced at whatever speed is required to deposit the metal supplied by the electrode wire, which is fed by the head in the usual way.

In Figure 2 is shown a roll as it appears after a continuous bead has been laid down on the cylindrical surface that required build-up. In this, as in other cases, the portion of the roll to be built up must first be heated to or about 400 F before welding is started. Thereafter, the heat of the arc maintains the required temperature. Preheating is done with gas torches as the work is rotated slowly, and an oxy-acetylene flame is sometimes applied briefly near the end of the preheat.

Where, as for the roll in Figure 2, a surface not requiring build-up must remain cool, a pan of water is placed as shown and a smaller roller helps to apply water to the surface to be cooled. After preheating the work, the lathe carriage is traversed into position to bring the welding head into use. On the carriage there is also a reel of electrode wire, and the head includes the usual small hopper for feeding granular flux.

Practice in this plant is to employ L-60, or equivalent, mild steel electrode wire and, if the metal applied must be hard, to employ Lincoln No. H-545 flux that supplies the alloying elements required to yield specified hardness of coating. This flux is fed automatically, just as for conventional flux, in such a way as to keep the arc submerged.

When ready for welding, the control switch is actuated, flux feed starts and wire feeds down to establish and maintain the arc. At the same time, rotation of the work starts (or is continued), and the carriage lead screw is engaged so that the electrode is advanced (just as a cutting tool might be fed forward) at the rate necessary to form a continuous bead on the cylindrical surface. Surface speed (of rotation) becomes the welding speed and is set so that a bead of desired size is laid down.

This bead fuses, of course, not only with the parent surface being built up, but with the bead produced in the prior turn; hence, in effect, the weld metal forms a new and continuous sleeve that is welded to the surface built up. If required, multiple passes can be applied to increase the depth of build-up. Although individual beads are identifiable and do not form a smooth, cylindrical surface, they provide one that is readily finished to whatever smoothness is required.

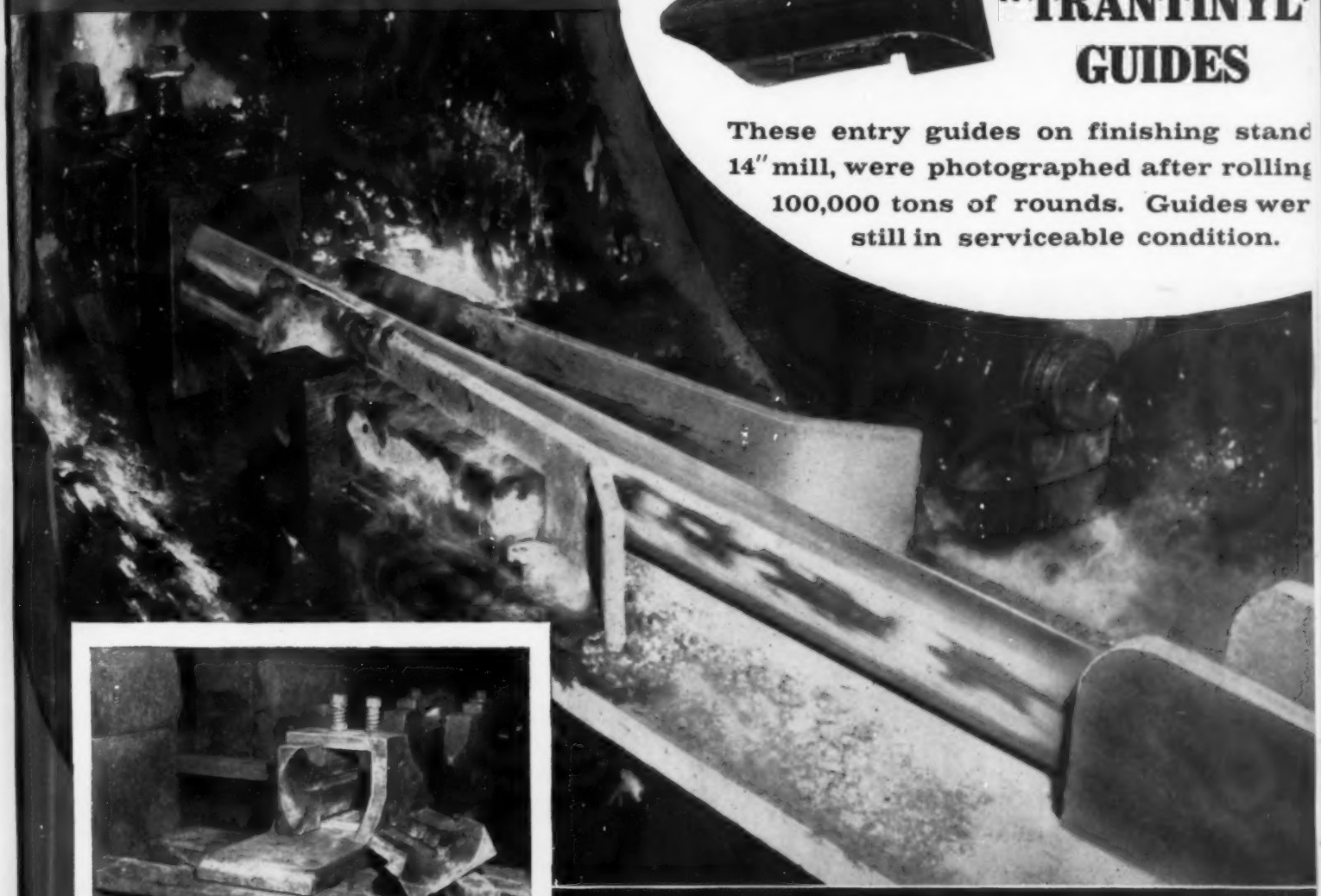
If straight H-545 flux yields higher hardness than is required, the flux can be mixed with other flux (such as L-80, for example) having no alloy ingredient, and the proportion can be adjusted to provide whatever intermediate hardness is wanted.

In making welds in this setup, the voltage applied is usually 30 volts and results in a welding current of 450 amp. Wire used is $\frac{3}{16}$ in. size and the usual deposit is about $\frac{1}{8}$ in. thick per pass. Although build-up is done most commonly on cylindrical surfaces, contoured rolls can also be built up, but, in this case, the operator must adjust the in-and-out feed in such a way that the electrode will follow the required contour. Built-up rolls are reported, in some cases, to wear less rapidly than new ones, and the cost of build-up and machining is always far below that for replacing the roll with a new one.

TRANTINYL GUIDES THE STEEL INDUSTRY

U. S. Steel Gary Works rolled 100,000 TONS with this pair of "TRANTINYL" GUIDES

These entry guides on finishing stand 14" mill, were photographed after rolling 100,000 tons of rounds. Guides wer still in serviceable condition.



14" Mill, Gary Works, with "TRANTINYL" Guides and Guide Box

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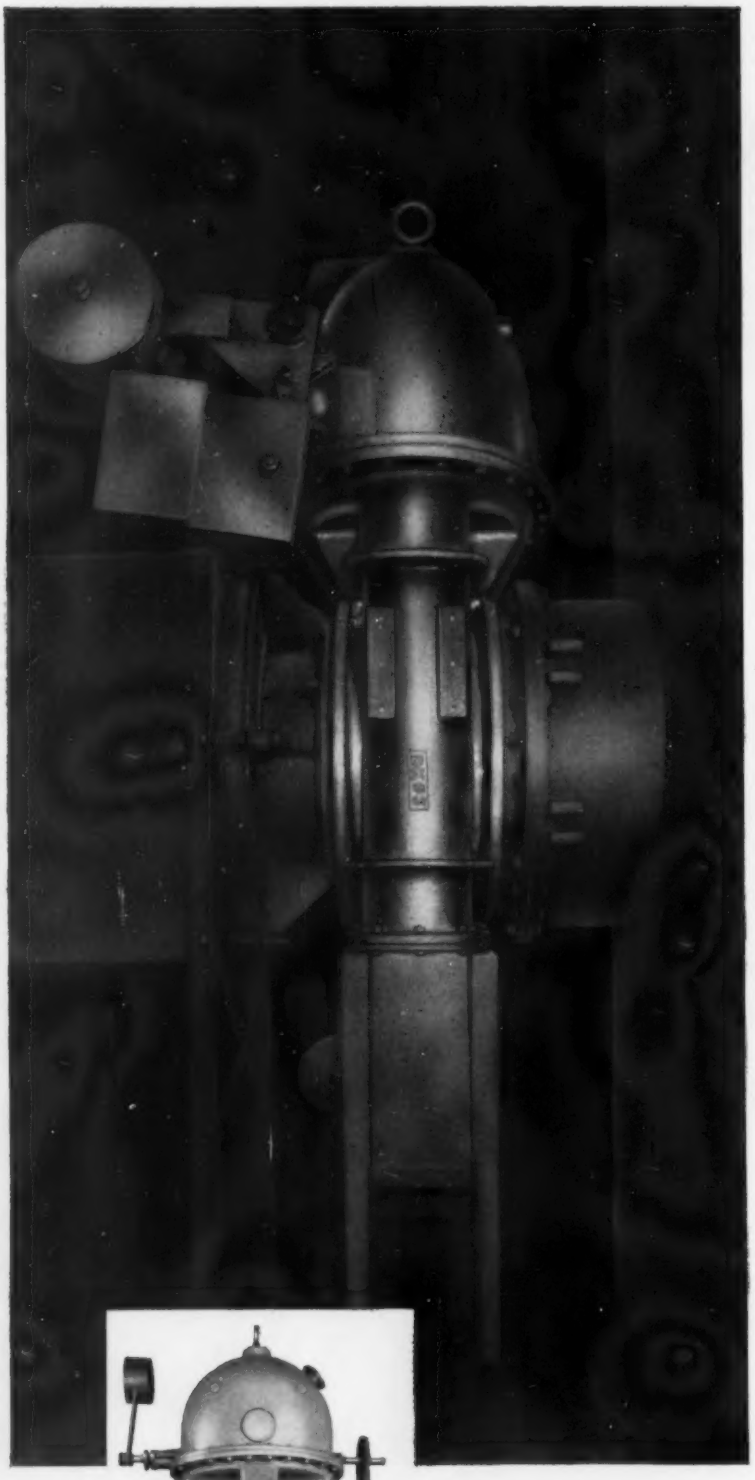
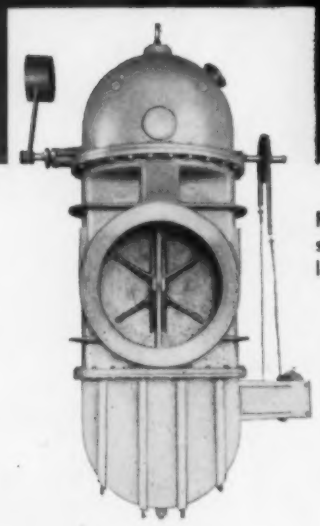
Surface
STEEL MILL EQUIPMENT

Freyn-Jansen Stove Valve





Freyn-Jansen Stove Valve reduces stove changing time, prevents gas leakage at the burner.

For over 25 years this stove valve has satisfied blast furnace operators in many countries. Here's why:

. . . reduces stove changing time

It replaces the conventional stove door providing quick, effortless action that saves time and work in opening and closing the burner inlet to the stove, regardless of burner opening size. A counterweighted valve operating shaft permits fast, easy operation either by manual lever, motor actuator or compressed air.

. . . prevents gas leakage

Permanently installed with bolted flanges between the burner discharge and the stove inlet, the Freyn-Jansen Valve prevents any gas leakage.

. . . provides tight, sure closure

It's designed so that cold blast pressure forces the valve against the seat, not away from it. In fact, the higher the pressure, the tighter the valve seats—makes it impossible for the disc to be blown off the stove.

. . . eliminates maintenance

The conventional stove door requires maintenance of its refractory lining and gasket between the door and stove. Neither refractory lining nor gasket at the valve seat is used on the Freyn-Jansen Valve.

Send for descriptive information that gives you all the facts, or consult our engineers.

KOPPERS

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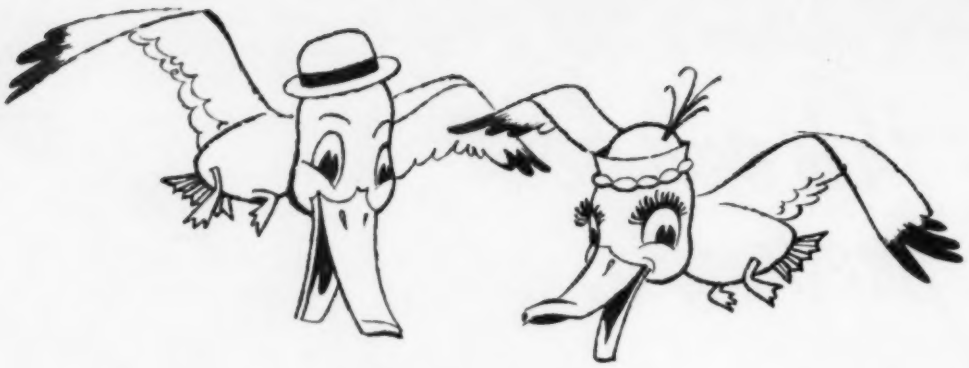

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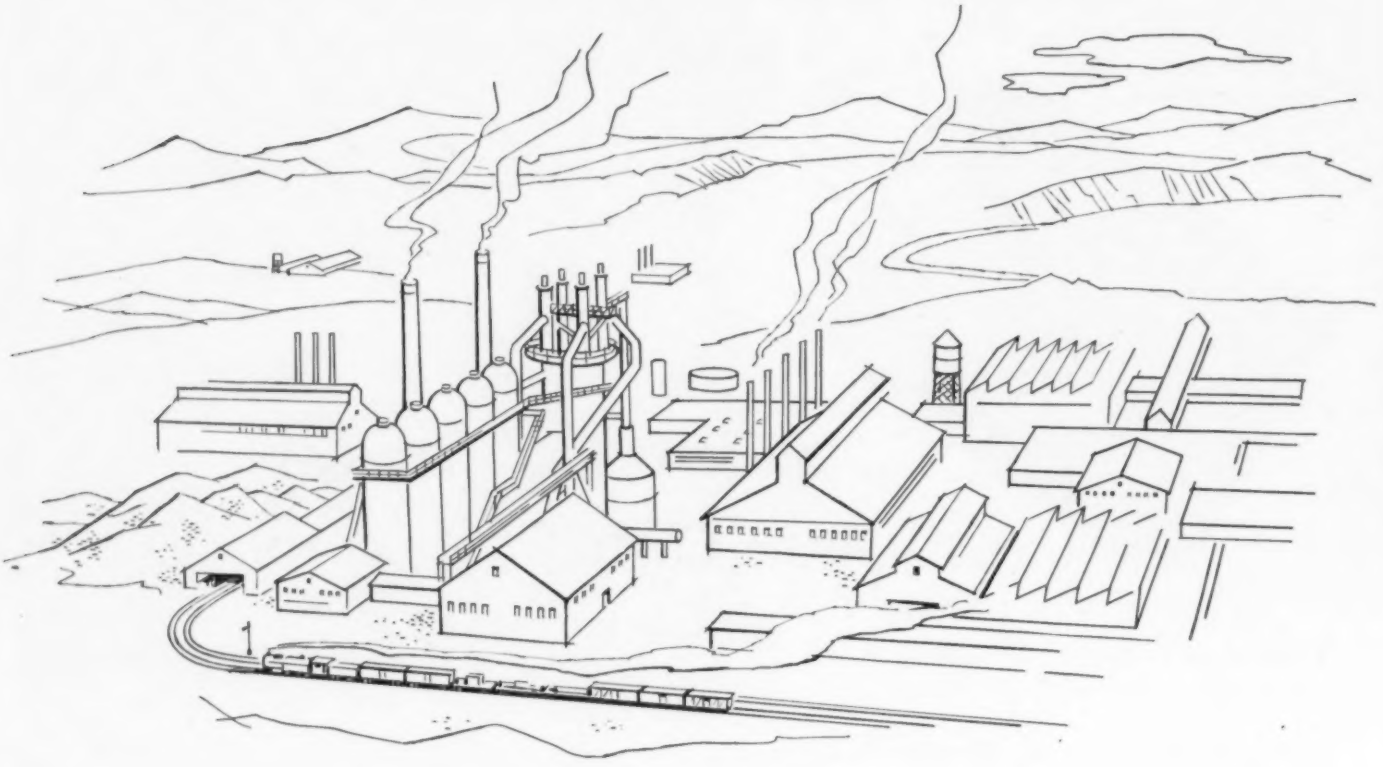

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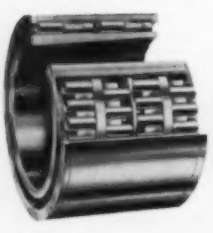

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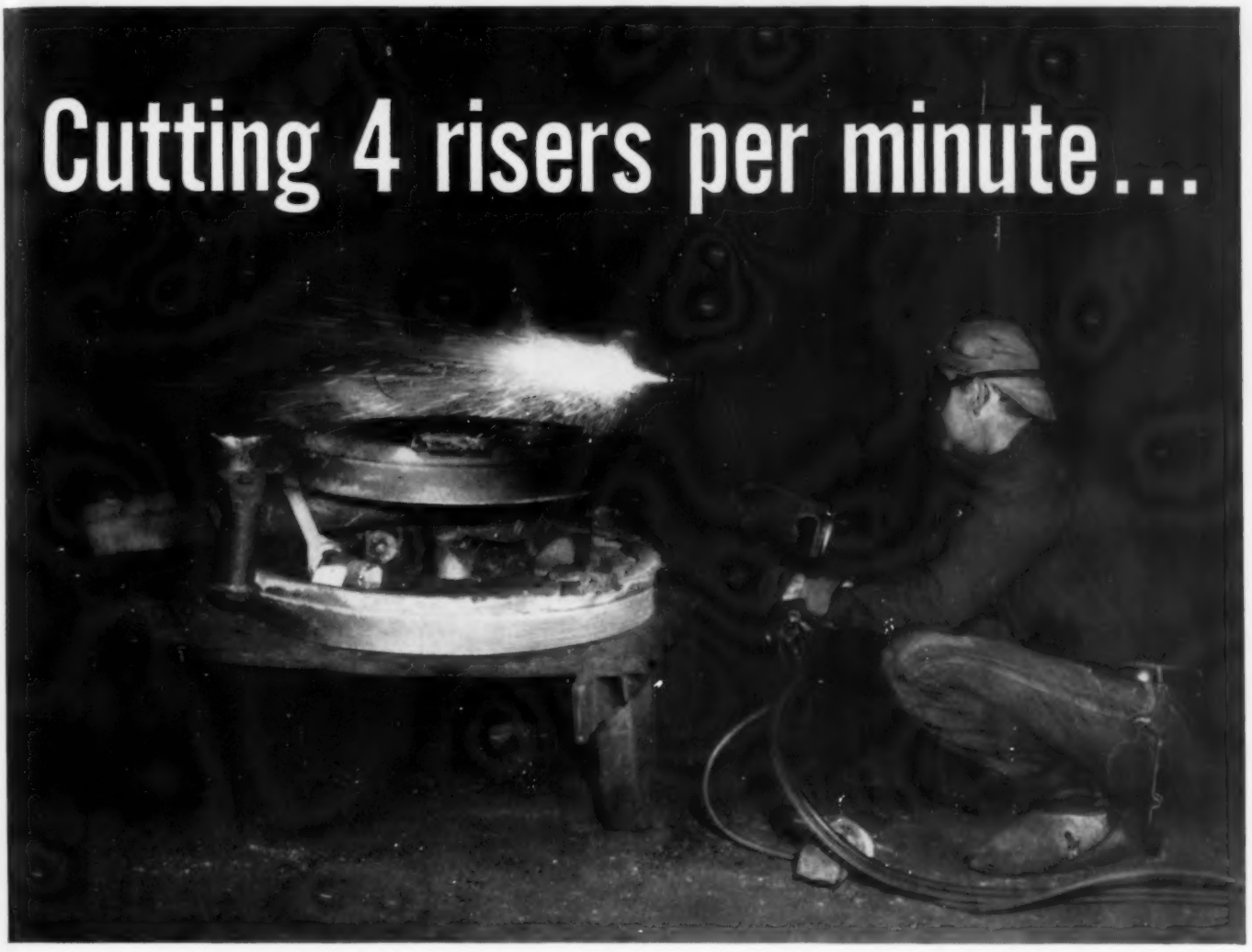

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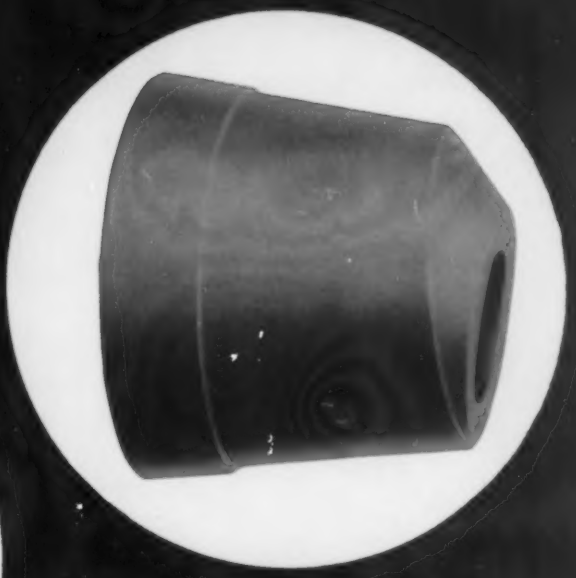

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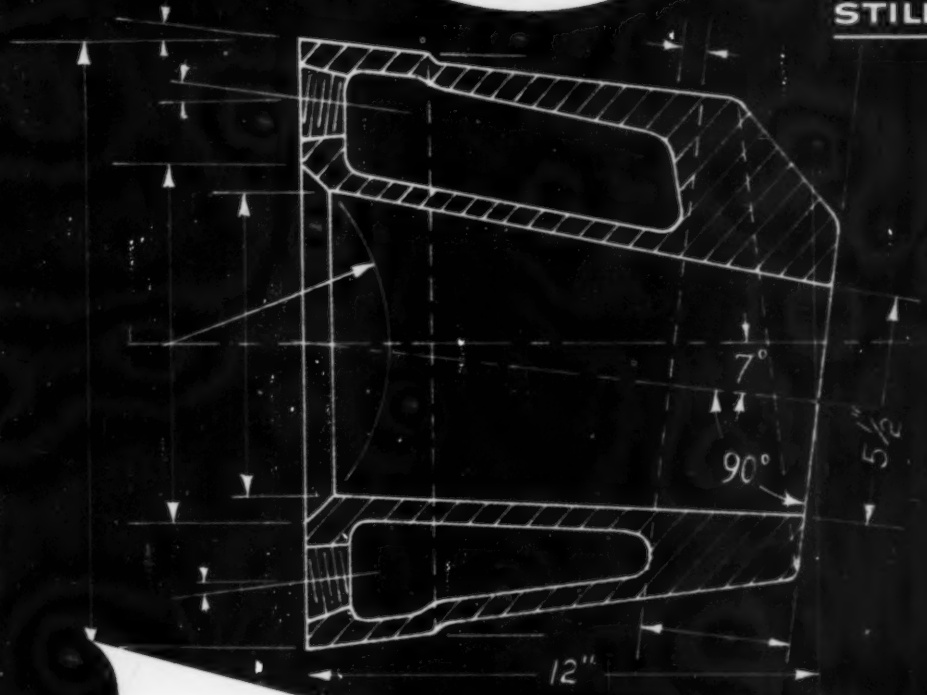
STILL NO LEAKS !



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Date-line Diary...

October 1

▲ The business of the West Virginia Steel and Manufacturing Co. was acquired by the Connors Steel Division of H. K. Porter Co., Inc., and will be known as the West Virginia Works, Connors Steel Division.

▲ The AISI reports that the operating rate of the steel industry for the week of October 1 is scheduled at 101.4 per cent of capacity. This is equivalent to 2,495,000 tons compared with 2,502,000 tons one week ago and 2,334,000 tons one year ago. Index of production for the week is 155.3. The production of steel last week of 2,502,000 tons or 101.6 per cent of capacity is the highest weekly production on record, being 19,000 tons over the previous high.

October 2

▲ The AISC reported bookings for August 1956 of 268,273 tons compared 288,166 tons in July and 312,338 tons in August, 1955. Shipments in August totaled 213,495 tons compared with 165,470 tons in July, 1956 and 268,362 tons in August, 1955. Backlog at the end of August was 3,076,163 tons.

▲ According to the Bureau of Census report shipments of iron and steel castings for July 1956 totaled 934,935 tons compared with June, 1956 shipments of 1,392,452 and July, 1955 total of 1,243,156 tons.

October 3

▲ Consumer debt in August increased $324,000,000 to a total installment debt of $29,400,000,000, more than $3,200,000,000 higher than August, 1955.

▲ Trade sources estimate aluminum production in the U. S. for 1956 will be about 1,675,000 tons, 7 per cent above 1955.

October 4

▲ National Steel Corp. of Pittsburgh filed $55,000,000 first mortgage bond issue due 1986 with the SEC. Proceeds will be used to cover the corporation's over-all construction program, increasing its annual steel ingot capacity 1,000,000 tons to 7,000,000 tons by the end of 1958.

▲ Bituminous coal producers signed a new wage contract with the union granting soft coal miners increases and fringe benefits totaling $2.40 daily; with pay boosts of $1.20 effective October 1, and 80¢ April 1, 1957.

▲ Applications totaling $1,500,000,000 for rapid amortization of expansion projects now on file by steel companies will await several months for a decision. Defense mobilizer Flemming said he could issue no ruling until the Department of Defense completes new estimates on steel requirements for the armed services which will not be available until the last of 1956 or early in 1957.

October 5

▲ No. 1 heavy melting steel scrap rose to $55 a ton on the west coast, $3 to $5 above the price a month ago.

▲ Bethlehem Steel Co. has agreed to purchase 3 soft coal mines in east Kentucky from Pittsburgh Consolidation Coal Co., increasing Bethlehem's output of coal by 2,500,000 tons annually.

▲ Government figures showed that construction outlays for September totaled $4,200,000,000 down $12,000,000 from the August, 1956 level, but $119,000,000 above September, 1955. Total for the first 9 months of 1956 was $32,600,000,000, 2 per cent above last year.

October 8

▲ The AISI reports that the operating rate of the steel industry for the week of October 8 is scheduled at 102.0 per cent of capacity. This is equivalent to 2,511,000 tons compared with 2,506,000 tons one week ago and 2,330,000 tons one year ago. Index of production for the week is 156.3.

▲ Chairman Arthur Burns of the President's Council of Economic Advisers advised that the national production of goods and services is now running at $414,000,000,000 annually, compared with the yearly rate of $408,000,000,000 during the June quarter.

▲ Marquette Iron Mining Co. made the first shipment of 4,999 tons of treated and pelletized iron ore from low-grade jasper deposits in northern Michigan's Marquette Range last week. Officials of Cleveland-Cliffs, who partially own the Marquette company, announced they expect shipments to total 70,000 tons before ice forces winter layups.

October 11

▲ Bureau of Statistics reports that Canadian output of pig iron for September, 1956 totaled 296,669 tons, up 7 per cent from 276,795 tons a year ago; steel ingots increased 14 per cent to 419,966 tons from 367,005 tons last year. Nine months production in 1956 rose to 2,649,520 tons of pig iron from 2,354,034 tons up 12 per cent over 1955; steel ingots totaled 3,847,361 tons up 19 per cent from 3,210,801 tons in 1955.

October 12

▲ Bureau of Mines reports that consumers stocks of scrap and pig iron at the end of August, 1956 totaled 8,349,000 gross tons, down 4 per cent from similar stocks held August 31, 1955; consumption of scrap and pig iron in August equalled 10,051,000 gross tons, 14 per cent less than August of 1955.

▲ The Agriculture Department acquired $28,000,000 worth of lead and zinc for U.S. stockpiles in August resulting from barter deals with foreign countries in exchange for government-owned farm commodities.

October 15

▲ The AISI reports that the operating rate of the steel industry for the week of October 15 is scheduled at 101.7 per cent of capacity. This is equivalent to 2,504,000 tons compared with 2,483,000 tons one week ago and 2,386,000 tons one year ago. Index of production for the week is 155.9.

▲ The Labor Department reported that work was begun on 93,000 dwelling units, down 8,000 from August, 1956 and down 21,900 from September, 1955. The VA reported it was requested to appraise only 30,007 proposed new homes in September, 6,000 less than in August, 1956 and 15,000 below the year-earlier level.

▲ Sheffield Steel, a subsidiary of Armco Steel Corp., will purchase the Ford Motor Co., assembly plant at Kansas City for use in its modernization and expansion program and to provide greatly needed space for relocation of existing facilities now operating in various parts of the Sheffield plant.

October 16

▲ F. W. Dodge Corp. reports that contract awards for future construction during September in the 37

states east of the Rockies totaled $2,024,794,000, less than one per cent below September, 1955. Contracts for future homes construction amounted to $763,-817,000, 4 per cent above September, 1955.

October 17

▲ Tin prices in New York rose 1¢ to $1.07½ lb for immediate delivery; quotations in London and Singapore advanced about ¾¢ a lb. Price rise is attributed to the Suez situation, resulting in delay in shipments from the Far East and increase in transportation costs.

▲ Deliveries of new domestic freight cars in September totaled 3,444 cars compared with 5,364 in August, 1956 and 3,118 in September, 1955. Orders in September totaled 3,949 compared with 2,575 in August. Backlog of cars on order as of October 1, stood at 122,421 cars.

October 18

▲ At the annual meeting on October 29, stockholders of Carpenter Steel Co. will be asked to approve increase of authorized capital stock to 3,000,000 shares from the presently authorized 1,000,000 shares. Par will remain at $5.

▲ The Aluminum Association reported primary production of aluminum during September totaled 264,631,718 lb in comparison with 184,812,424 lb in August, 1956 and 261,231,951 lb in September, 1955.

October 22

▲ The AISI reports that the operating rate of the steel industry for the week of October 22 is scheduled at 101.1 per cent of capacity. This is equivalent to 2,489,000 tons compared with 2,495,000 tons one week ago and 2,413,000 tons one year ago. Index of production for the week is 154.9.

▲ President Eisenhower disclosed that the program submitted to Congress next January will request lowering of the Federal tax on corporate income to 20 per cent from 30 per cent on the first $25,000.

▲ The Industrial Heating Equipment Assn. reported that orders of industrial furnaces during September amounted to $3,057,000 compared with $8,350,712 a year ago. Orders for induction and dielectric heating equipment in September, 1956 amounted to $1,649,620, an increase of 49 per cent over the total of $1,107,690 for the same month last year.

October 24

▲ Ford Motor's report for the third quarter of 1956 showed sales at $868,000,000 with net profits of $0.25 per share, compared with sales of $1,151,-000,000, net profit $1.45 per share for the same period in 1955; in the first nine months of 1956, sales totaled $3,200,000,000, profit per share $2.69 and for the same period in 1955, sales were $4,000,-000,000, and net profit per share $5.85.

October 25

▲ General Motors profit dropped to 48¢ per common share for the third quarter of 1956, compared with 90¢ per share a year ago; net for the first nine months decreased to $2.28 per share from the $3.31 in the same period of 1955. Sales for the nine month period in 1956 amounted to $8,100,000,000, down 15 per cent from the 1955 sales.

▲ Consensus of top executives of the machine tool industry is that incoming business in 1956 will run between $950,000,000 and $1,000,000,000; new orders received in the first nine months in 1956 totaled $737,000,000, 34 per cent above 1955.

October 26

▲ Bureau of Labor Statistics reported a 0.3 per cent increase in living costs in September to reach 117.1 per cent of the 1947-49 average.

▲ Prices on steel scrap advanced $1 to $2 a ton in Pittsburgh. Prices were buoyed by prospects that steel mills will continue operation at capacity or higher well into 1957.

▲ AISI reports the estimated total August payroll for the iron and steel industry amounted to $300,-920,000; estimated total employment, 677,200; average hourly payroll cost for wage earners, $2.697 (plus an average cost of about 25¢ an hour for pensions, social security and insurance, estimated on an annual basis). Average hours worked were 34.2.

▲ F. W. Dodge Corp. reports that according to the collective opinion of 221 of the nation's leading economists it polled, 1957 will be the best business year in history, with inflation accounting for much of the rise in the dollar indicators of business activity. New plant and equipment expenditures in 1956 are expected to rise to $35,000,000,000 compared with $29,000,000,000 in 1955.

October 29

▲ Joel Hunter, president of Crucible Steel Co. of America, announced that the company has acquired the entire interests of National Research Corp. in Vacuum Metals Corp., which now becomes a wholly-owned Crucible subsidiary.

▲ The AISI reports that the operating rate of the steel industry for the week of October 29 is scheduled at 101.0 per cent of capacity. This is equivalent to 2,486,000 tons compared with 2,491,000 tons one week ago and 2,400,000 tons one year ago. Index of production for the week is 154.8.

October 30

▲ Resistance Welder Mfgrs. Assn. reported that shipments by members during September, 1956 were in excess of $4,000,000.

October 31

▲ Eastern and Western railroads are pushing the ICC for speedy approval for about 7 to 15 per cent rate increase as filed, to offset anticipated wage boosts to be granted from current labor negotiations. Southeastern lines are reportedly considering joining forces for interim rate increases though no applications have been filed.

▲ Youngstown Sheet & Tube Co. acquired a 52-acre site at Boardman, Ohio, six miles south of Youngstown, for a general office building at an estimated price of $190,000.

▲ Seasonal markups by producers advanced prices of hard coal 25 to 75¢ a ton.

▲ Westinghouse Electric Corp. reported, for the quarter ended September 30, 1956, sales totaling $409,717,000, net profit $10,314,000, earnings per share 59¢, compared with sales of $378,468,000, profit $14,422,000 and earnings per share 84¢ in the same period in 1955; for the nine-month period ended September 30, sales totaled $1,015,814,000, net loss amounted to $1,399,000, compared with sales of $1,134,431,000, profit of $43,839,000 and earnings per share of $2.55 in the same period ended September 30, 1955.

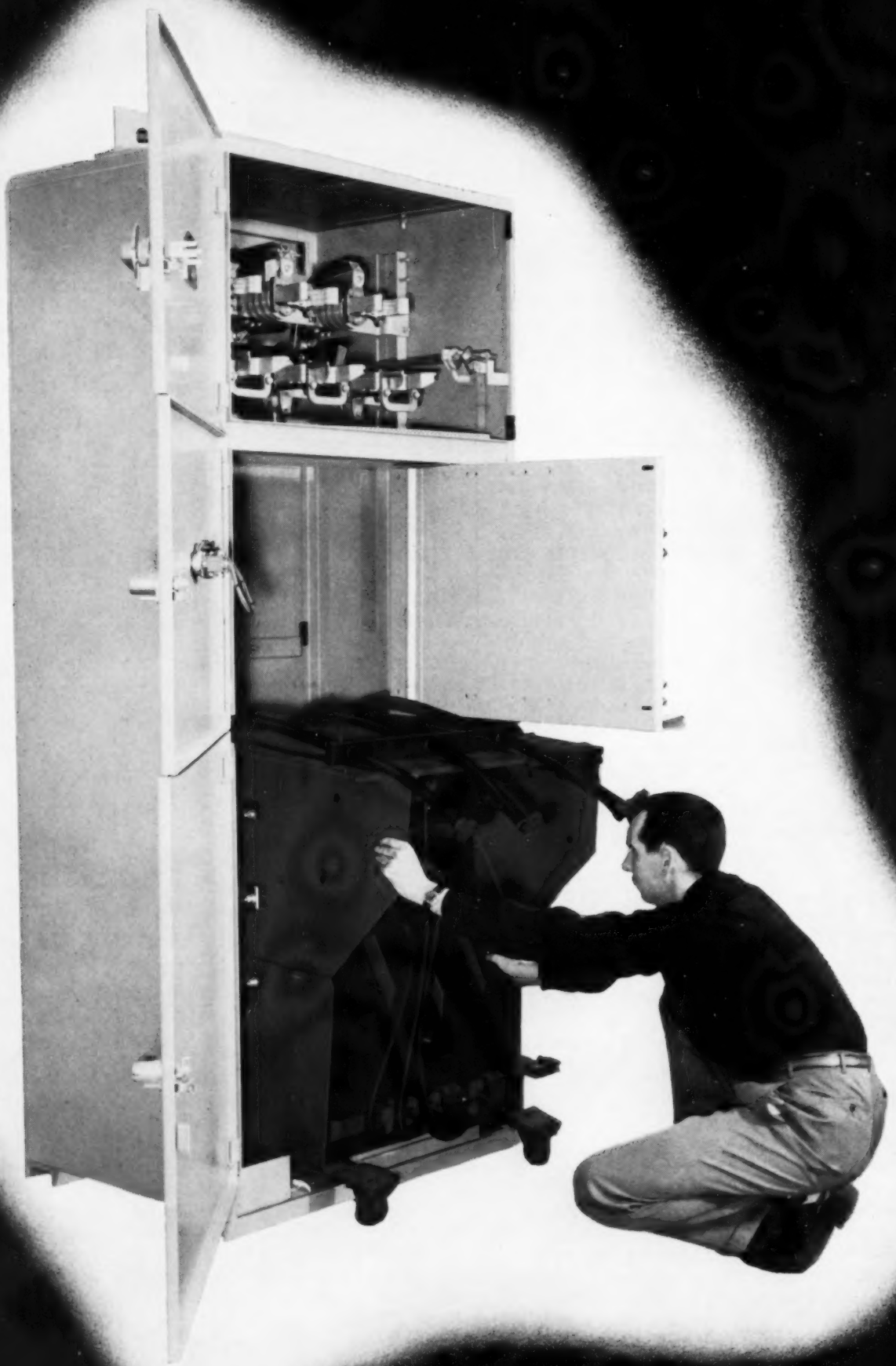
▲ Bureau of Census reports that shipments of iron and steel castings for August, 1956 totaled 1,337,448 tons compared with 934,935 tons in July 1956, and 1,435,166 tons in August, 1955; unfilled orders at August 31, 1956 equalled 1,752,000 tons.

▲ Electro Metallurgical Co., a division of Union Carbide and Carbon Corp., announced that all tungsten alloy prices have been lowered 30¢ per lb of contained tungsten, resulting in price reductions on ferrotungsten, tungsten metal powder, and calcium tungstate nuggets.

Steel Companies Quarterly Financial Reports —Ending Sept. 30, 1956

	Period	1956 Net sales	1956 Net profit	1956 Earnings per share	1955 Net sales	1955 Net profit	1955 Earnings per share
Acme Steel Co.	Third quarter	$ 23,710,003	$ 885,163	$0.45	$ 26,153,631	$ 1,412,783	$0.71
	First 9 months	86,264,961	4,756,360	2.39	79,354,091	4,808,084	2.42
Allegheny Ludlum	Third quarter	48,810,742	566,445	0.15	64,983,067	4,015,512	2.29
	First 9 months	202,598,347	9,647,024	2.56 (After 2 for 1 stock split)	181,825,562	10,431,166	5.92
Alan Wood Steel Co.	Third quarter		754,266			714,272	
	First 9 months						
Armco Steel	Third quarter	163,394,343	9,106,917	0.83	179,252,980	17,364,452	1.63
	First 9 months	558,019,821	46,204,344	4.25	508,774,647	45,384,986	4.28
Atlas Steels, Ltd.	Third quarter		750,000	0.87		257,658	0.31
	First 9 months		2,925,850	3.40		1,165,942	1.40
Barium Steel Corp.	Third quarter		1,929,000	0.56	18,748,468	418,000	0.13
	First 9 months	87,026,000	4,843,000	1.42	50,621,000	41,031	0.01
Bethlehem Steel Co.	Third quarter	389,610,779	4,428,143	0.29	521,809,969	40,369,984	4.04
	First 9 months	1,659,520,921	99,690,157	9.81	1,523,822,403	122,689,308	12.29
Carpenter Steel Co.	First quarter (Fiscal year starts July 1)		1,307,228	1.52		1,118,344	1.31
Colorado Fuel and Iron	Third quarter		371,389	0.06		3,876,841	1.27
	First 9 months						
Continental Steel Corp.	Third quarter		609,370			676,469	
	First 9 months						
Copperweld Steel	Third quarter	21,621,433	621,707	0.73	17,728,958	444,136	0.74
	First 9 months	74,021,448	2,495,704	2.97	55,830,194	1,667,587	2.88
Crucible Steel Co.	Third quarter	44,195,729	510,226	0.28	57,051,575	2,752,293	1.52
	First 9 months	189,862,560	8,597,020	4.76	171,881,040	9,037,768	5.00
Detroit Steel Corp.	Third quarter	29,909,850	2,301,558	0.73	24,856,391	1,554,056	0.51
	First 9 months	93,627,873	6,444,109	2.05	74,287,185	4,179,220	1.38
Eastern Stainless Steel	First 9 months	35,942,275	2,525,288	4.35	26,282,246	1,700,642	2.93
Granite City Steel	Third quarter	32,949,196	3,717,746	1.74	30,196,316	3,553,513	1.66
	First 9 months	104,522,410	11,250,568	5.27	85,212,651	9,011,116	4.21
Inland Steel Co.	Third quarter	139,816,540	6,529,999	1.17	166,401,313	13,017,963	2.38
	First 9 months	530,819,524	35,490,480	6.34	481,431,923	36,437,815	6.67
Interlake Iron	Third quarter	24,605,087	1,234,894	0.55	22,945,674	1,866,893	0.96
	First 9 months	77,328,789	5,131,198	2.30	71,201,642	5,869,679	3.01
Jones & Laughlin Steel	Third quarter	129,257,000	1,360,000	0.13	182,390,000	12,267,000	1.89
	First 9 months	537,947,000	32,269,000	4.88	513,681,000	34,835,000	5.40
Kaiser Steel	Quarter		6,875,545		39,627,209	2,823,645	0.70
					136,148,919	5,741,236	1.08
Keystone Steel & Wire	Third quarter		1,727,715	0.92		2,158,743	1.15
Lukens Steel Co.	First 36 weeks (ending Sept. 8	67,699,621	4,262,297	13.40	56,470,424	1,341,652	4.22
McLouth Steel Corp.	Third quarter		1,315,910	0.67		2,110,868	1.18
	First 9 months)		6,333,541	3.57		5,030,939	2.67
National Steel	Third quarter	133,345,718	6,514,649	0.88	154,159,739	11,468,806	1.55
	First 9 months	480,985,383	35,476,059	4.80	462,551,990	34,501,677	4.68
Pittsburgh Coke and Chemical	Third quarter	15,263,000	700,000	0.52	15,030,000	828,000	0.75
	First 9 months	49,383,000	2,667,000	2.06	43,013,000	2,478,000	2.26
Pittsburgh Steel Co.	Third quarter	29,825,249	(348,190) Loss	(0.45) Loss	44,714,987	2,145,983	1.21
	First 9 months	131,734,027	4,432,917	2.30	129,338,012	4,720,760	2.49
Republic Steel Corp.	Third quarter	201,850,874	4,305,948	0.28	299,646,028	22,005,740	1.43
	First 9 months	885,903,517	55,838,400	3.61	866,547,917	63,142,811	4.09
Rotary Electric Steel Co.	Third quarter		6,427			960,227	
Sharon Steel	Third quarter	28,403,871	301,507	0.27	41,827,803	1,776,903	1.61
	First 9 months	129,082,858	4,627,139	4.20	125,464,254	6,264,905	5.69
United States Steel	Third quarter	764,991,210	34,785,870	0.52	1,035,804,426	89,623,983	1.55
	First 9 months	3,034,281,345	243,336,311	4.18	3,003,965,411	267,506,943	4.65
Washington Steel Co.	Third quarter		499,003			574,919	
Wheeling Steel	Third quarter	42,635,000	525,000	0.04	64,264,000	4,206,000	1.97
	First 9 months	186,703,000	11,924,000	5.54	183,273,000	10,862,000	4.99
Youngstown Sheet and Tube	Third quarter		3,381,000	7.30	156,624,751	11,328,000	3.33
	First 9 months				451,036,133	29,247,179	8.66

HIGH-VOLTAGE MOTOR CONTROL.....



GENERAL ELECTRIC LIMITAMP* STARTERS OFFER ROLL-OUT CONTACTOR UNITS FOR EASIER INSTALLATION

Today's General Electric Limitamp starters are designed to bring you the utmost in installation ease, speed, and economy.

Key feature of this cost-cutting design is the caster-mounted contactor unit which can be easily rolled into or out of the Limitamp enclosure. After swinging out the hinge-mounted low-voltage panel, and before rolling in the contactor unit, the installation man can walk right inside the enclosure to make connections quickly and conveniently.

Once connections are completed, the panel can be closed and ready to operate within seconds. Limitamp panels control and protect motors rated 2300 to 4800 volts and ranging up to 3000 horsepower.

MORE LIMITAMP CONTROL FEATURES

Fast, economical installation is but one benefit of General Electric Limitamp control. There are many more. For instance:

- Five-square-foot saving of floor space through use of higher-capacity fuses to eliminate need for an extra fuse cabinet.
- Increased personnel safety provided by three-phase disconnect switch.
- Flexible arrangement of units and added space savings, with all connections made from front.
- Complete range of modifications to meet any installation requirement.

REALIZE THESE BENEFITS NOW

Don't be satisfied with "old-fashioned" high-voltage motor control: Specify General Electric's Limitamp control—*leader in design and performance.* Contact your G-E Apparatus Sales Office today, or write Section 783-2, General Electric Company, Schenectady, New York.

Industry Control Department, Roanoke, Virginia.

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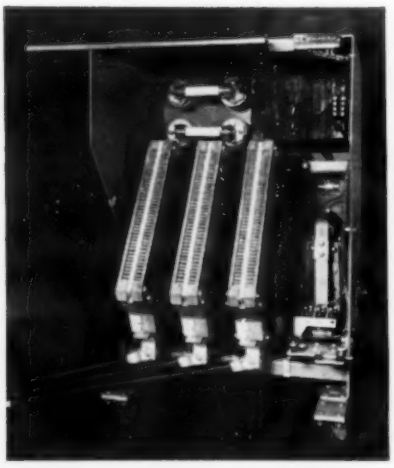
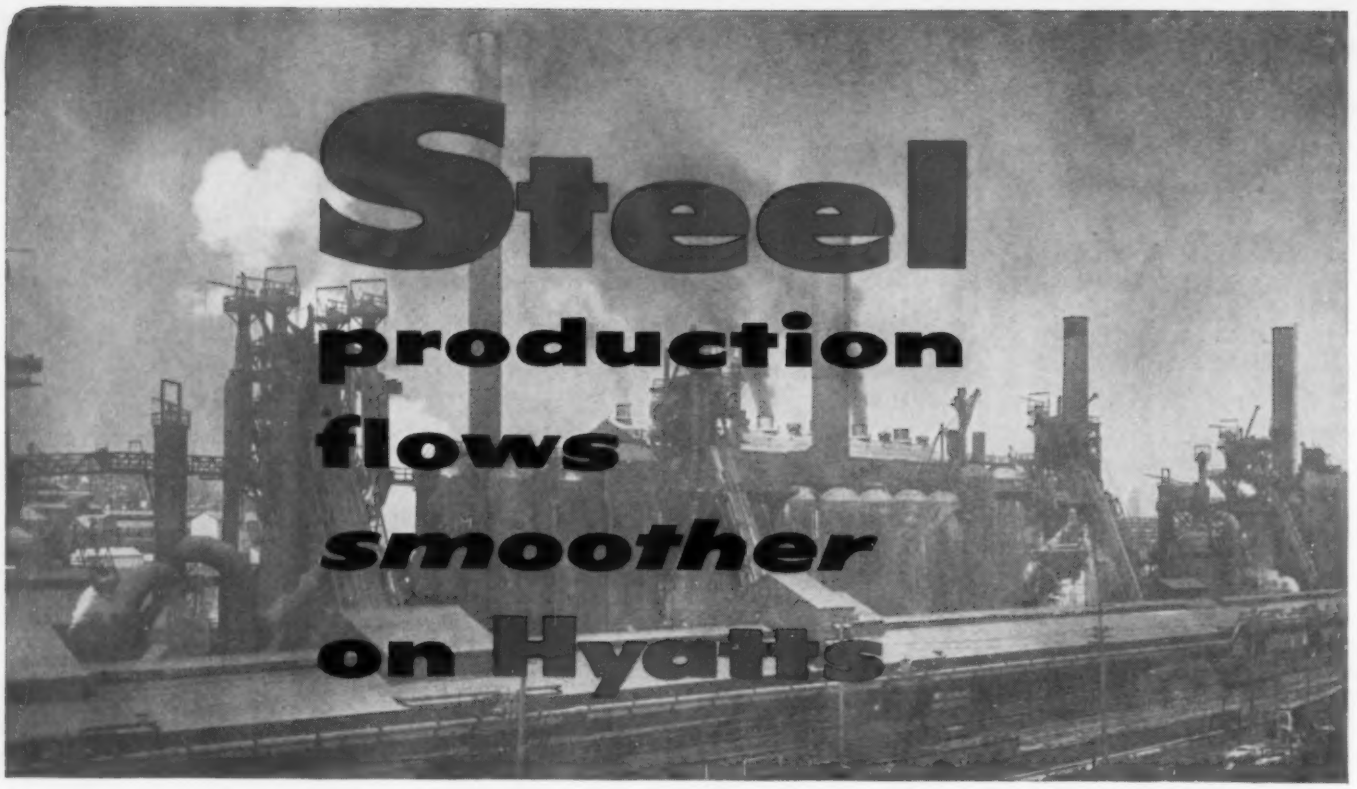
Progress Is Our Most Important Product

GENERAL ELECTRIC



MAINTENANCE EASY on contactor; generally devices are front-removed.

THERE'S AMPLE SPACE to stand inside enclosure and make necessary connections. Yet entire control requires 50% less floor space than before.



-from ingot cars to runout tables!

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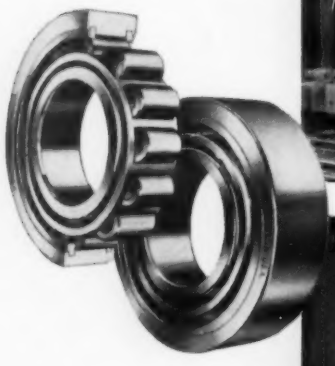

For years, wherever blast furnaces blaze and rolling mills rumble, HYATT Roller Bearings have been building an unsurpassed reputation in the steel industry. And today's HYATT Hy-Roll Bearings are better than ever—thanks to ultra-modern electronic equipment which assures even greater precision.

The millions we're investing in better bearing production can help save you thousands in better bearing performance. Insist on HYATT Hy-Rolls—every time! Hyatt Bearings Division of General Motors, Harrison, New Jersey.

This blooming mill set records with HYATTS on lineshaft, main, approach, runout tables.

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GM GENERAL MOTORS

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FOR STEEL INDUSTRY

bright annealing

OF STAINLESS STEEL TUBING

at 2050°F

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The combination of the Drever TUBE TYPE BRIGHT ANNEALING FURNACE with extended water jacketed cooling chamber, and the Drever AMMONIA DISSOCIATOR provides the right way to BRIGHT ANNEAL STAINLESS STEEL AND INCONEL TUBING.

Let our experience help solve your problems. Write or 'phone

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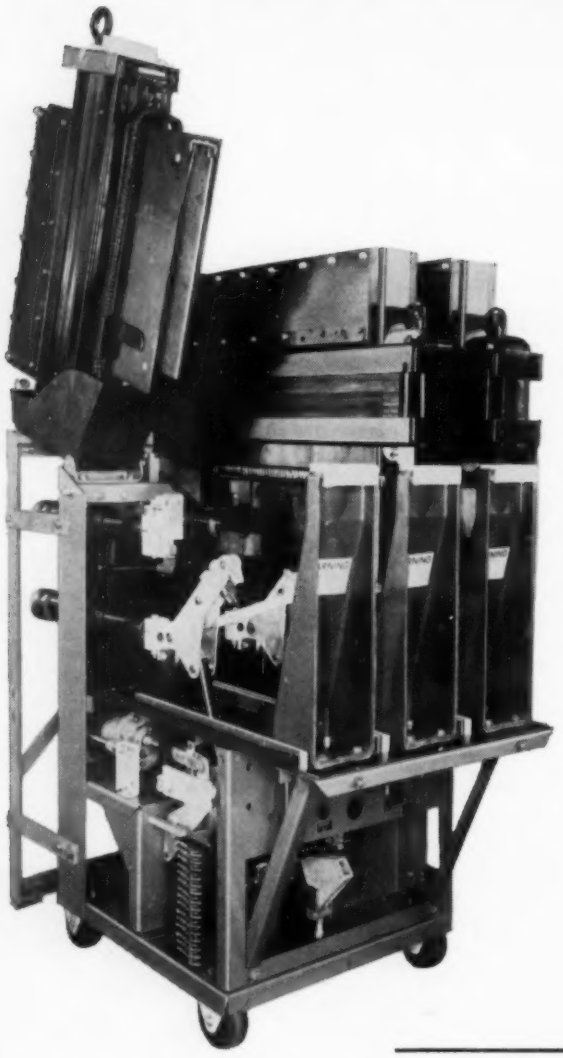
...here are the facts:

1—Fully Annealed
2—Absolutely Bright
3—No scale, oxides or scratches
4—No Carbide Precipitation
5—No pickling required before drawing
6—No pickling after finish anneal
7—Furnace can be gas or electrically heated
8—Capacities up to 2000 lbs./hour
9—Tubing from capillary size to 2½" O.D.

6



A Complete Line of I-T-E Metal-Clad Circuit Breakers for Every Application

Anticipating the proposed addition of three new higher metal-clad switchgear ratings, I-T-E now has a complete line of circuit breakers which are fully developed and tested to meet every requirement.

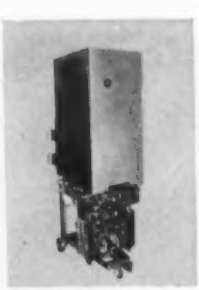
New 75 mva interrupting rating for I-T-E metal-clad switchgear applied on 4.16 kv systems

New 350 mva interrupting rating with a new 3000 amp continuous rating for application on 2.3 or 4.16 kv systems

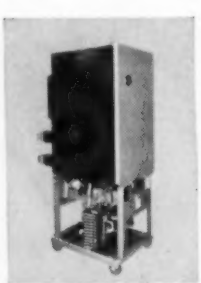
New 750 mva interrupting rating for application on 13.8 kv systems at 1200/2000 amp continuous

I-T-E Type	Continuous Amperes	Rated KV	Interrupting MVA
5HV-75	1200	4.16	75
5HV-150	600-1200-2000	4.16	150
5HV-250	1200-2000	4.16	250
5HV-350	1200-3000	4.16	350
7.5HV-250	1200-2000	7.2	250
7.5HV-500	1200-2000	7.2	500
15HV-150	600-1200	13.8	150
15HV-250	1200-2000	13.8	250
15HV-500	1200-2000	13.8	500
15HV-750	1200-2000	13.8	750

Note: These ratings require no change in I-T-E compartment dimensions.



5HV-75



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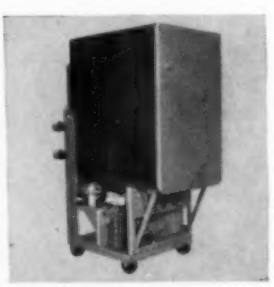

15HV-750

For complete information, call your nearest I-T-E sales office. Or write I-T-E Circuit Breaker Company, 19th & Hamilton Streets, Philadelphia 30, Pa.

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MAKE SURE YOUR NEXT BULK MATERIALS UNLOADER HAS THESE IMPORTANT DRAVO FEATURES:

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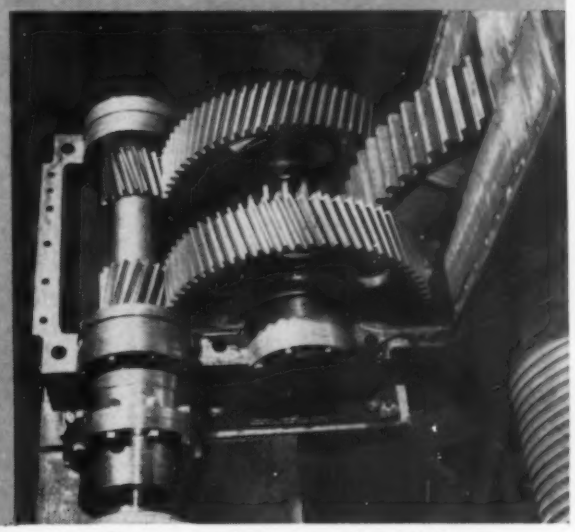

Gearing for one drum of a trolley hoist—Gears, shaft and bearings in sealed steel cartridges installed as unit assemblies in a heavy, welded, oil tight gear case. Accurate alignment assured.

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Low Maintenance Costs, Low Operating Costs

Unit construction of mechanical parts is only one of the ways Dravo keeps operating costs at a low level. Each structure is individually designed to handle its specific job economically, dependably and safely. Such performance is achieved by bringing together the customer's operating knowledge and the experience of Dravo's research, design and construction men.

This method has resulted in high efficiency unloaders and other bulk materials handling equipment that produce because they are tailored to fit the job.

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We ran this

B&W Insulating Firebrick

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24 years now

Photo courtesy Sun Shipbuilding & Dry Dock Company

Only in main arch approximately 2 feet from each end of the furnace

The furnace that PAID FOR ITSELF MANY TIMES OVER

Still lined with its original B&W Insulating Firebrick after 15 years of normalizing and stress-relieving service, this furnace is giving exceptional performance. Despite the added strain of the rigorous war years, the 80,000 B&W IFB used to line sides, ends and arch have required no appreciable maintenance!

It is no wonder the operators can report:
"This furnace has paid for itself many times over."

For furnace performance that assures highest production at lowest cost, even after years of grueling service, you can always count on lightweight B&W Insulating Firebrick. Your local B&W Refractories Engineer will be glad to help you select economical B&W Refractories for your furnaces.

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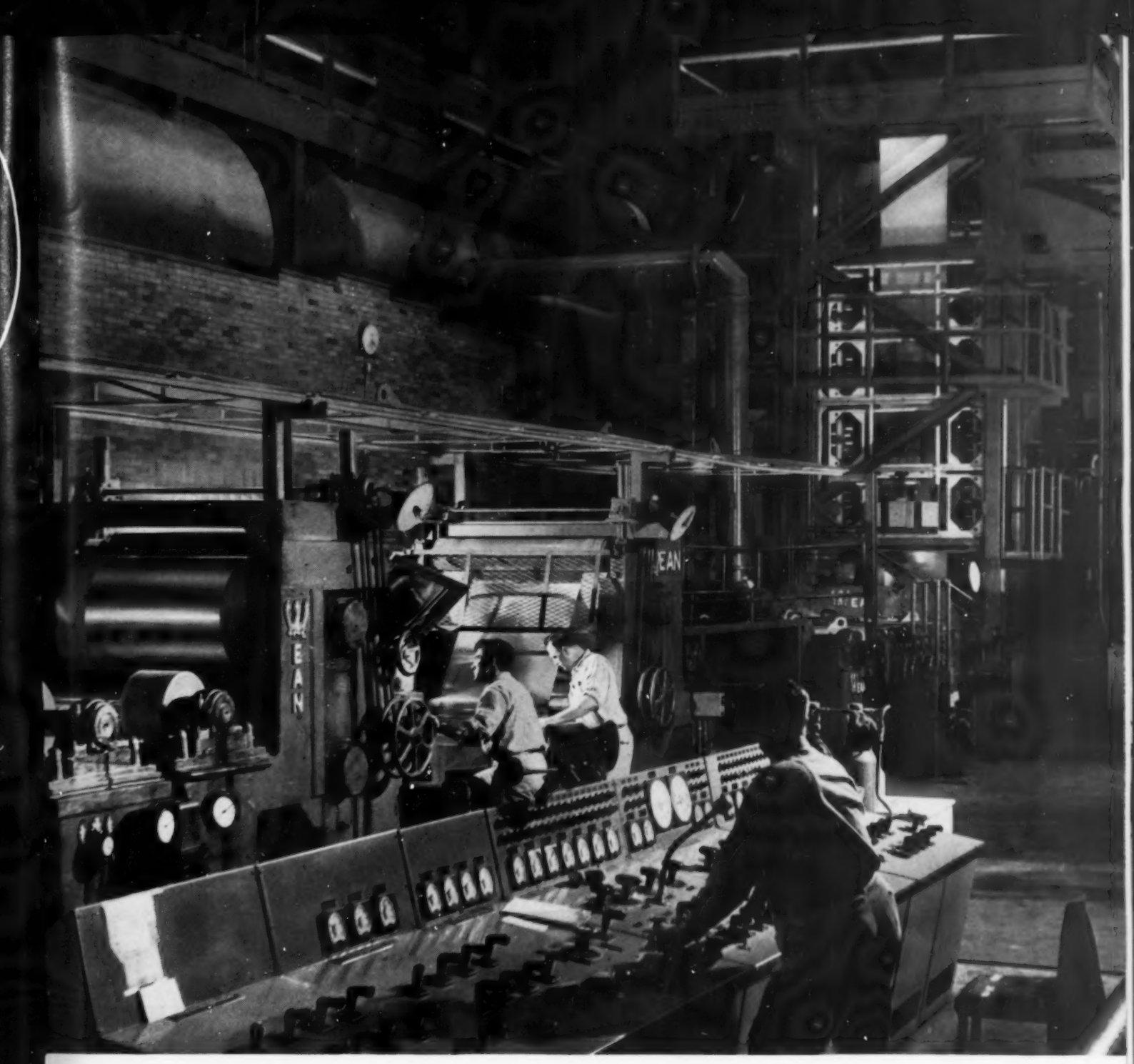


More tin plate . . . mirror finish, precise alloy

Westinghouse line drive and control equipment for exacting, high-speed reflow methods helps your electrolytic tinning lines produce more salable tin plate . . . faster.

Here's how you can give your tin plate a competitive edge ⟶

WATCH WESTINGHOUSE!

*WHERE **BIG** THINGS ARE HAPPENING **TODAY!***

With Westinghouse radio-frequency equipment . . .

Smooth, lustrous tin plate at speeds of 2100 fpm, and beyond

Westinghouse equipment for tin-plate reflow operations helps you produce the delicate alloy balance necessary to form tin cans easier, maintain high production rates.

Westinghouse radio-frequency induction heating equipment for high-speed lines . . . both horizontal and vertical acid type . . . keeps coating thickness precise and constant by automatically adjusting plating current in proportion to line speed. Electromagnetic induction, transferring power to the strip without physical contact, melts the tin and creates a bright, nonporous surface.

This process works so fast that it produces an actual flow line on the moving strip. A photoelectric scanner continuously scans the flow line and uses it to maintain heating at the precise, desired level. There's no overheating or underheating . . . the electric equipment is capable of maintaining speeds of 2100 fpm and beyond. You save valuable tin, reduce menders and boost output of prime tin plate. Production scheduling is simplified because photoelectric scanner handles most changes in gauge and speed without adjustment.

How Line Control Operates

Magamp* magnetic amplifier regulators (VR) control voltage of the entry, main and delivery generators assuring fast, even acceleration and deceleration and minimum loop variation during steady operation. Loop regulators act as verniers in controlling generator voltages.

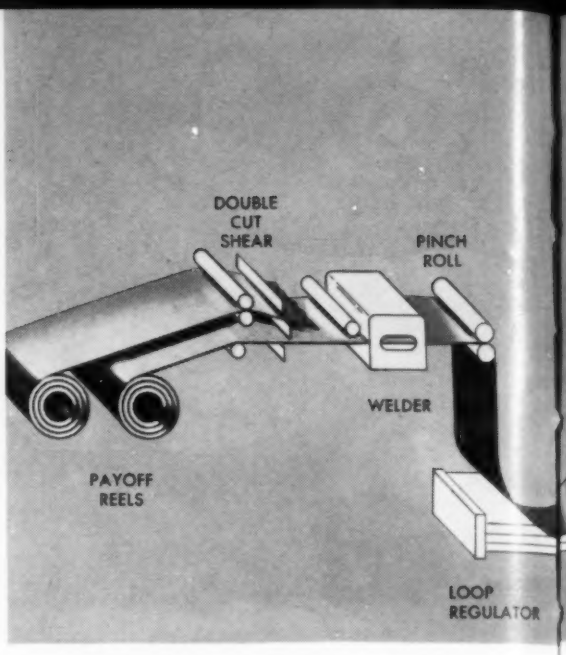
Magamp current regulator (CR) for booster and Magamp counter emf regulator (CEMFR) for motor work together to maintain regulated tension by the pay-off reels (POR) and winding reels (WR). Inertia compensation (IC), proportional to accelerating loads and stall tension signals, is introduced through the (CR) circuits.

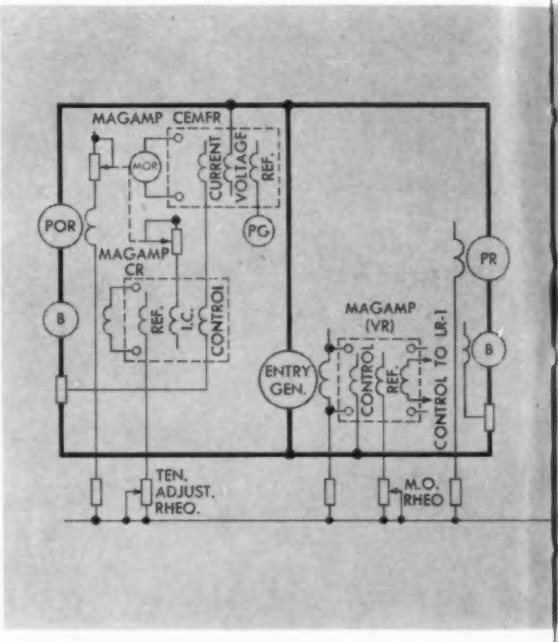
Photo-thyratron loop regulators (LR) provide modulated control of storage loops for smooth operation.

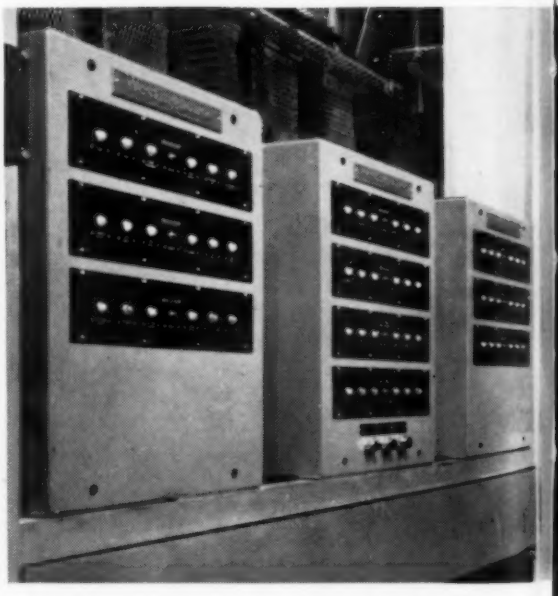
Electronic regulators control top and bottom plating current to deposit proper tin coating on each side at all line speeds.

Machine characteristics are selected for optimum drive performance. Entry section pinch roll (PR), master bridle roll (MBR), and drag bridle No. 2 (DB-2), the pace setters of their respective line sections, are shunt-wound for flat speed-load characteristics. Tank drives (T) have high drooping characteristics which result in their developing only the power required to overcome their friction losses and inertia loads. Reel motors have overload capacities suitable for accelerating the large coils now used in most mills.

*Trade-Mark.





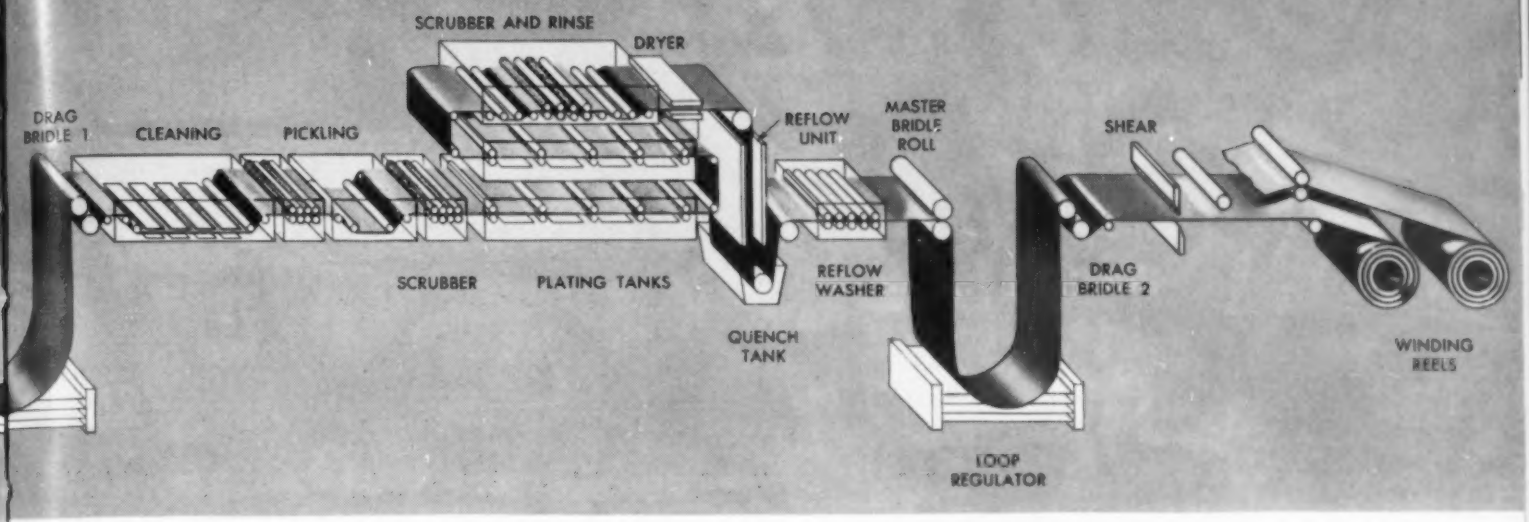


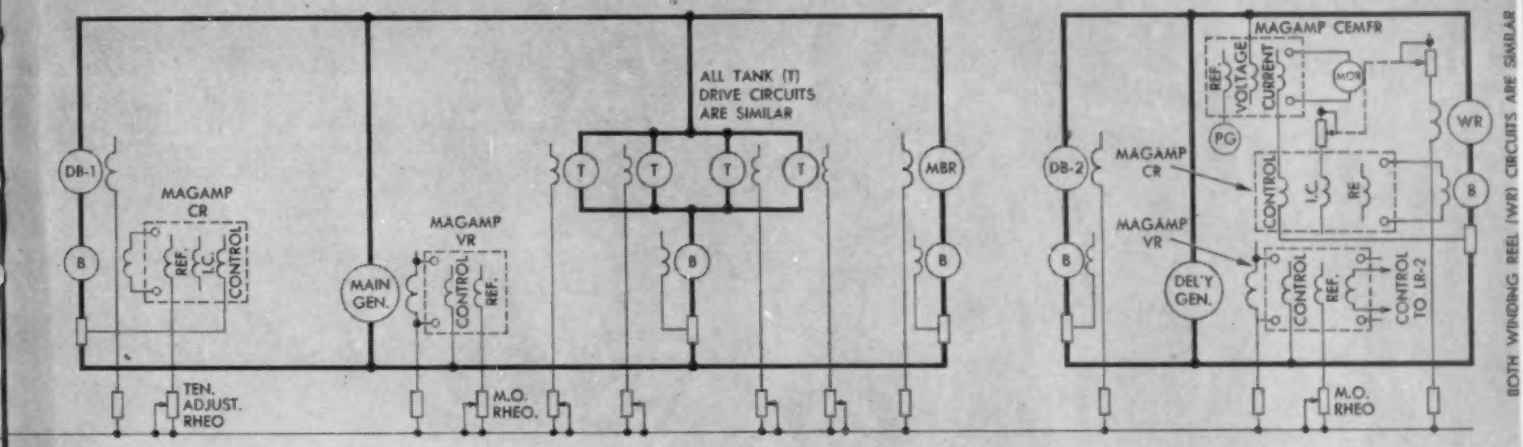
New Westinghouse fault finder monitors control circuits simultaneously, indicates system faults instantly . . . remembers them . . . makes trouble shooting easy.

WATCH WESTINGHOUSE!

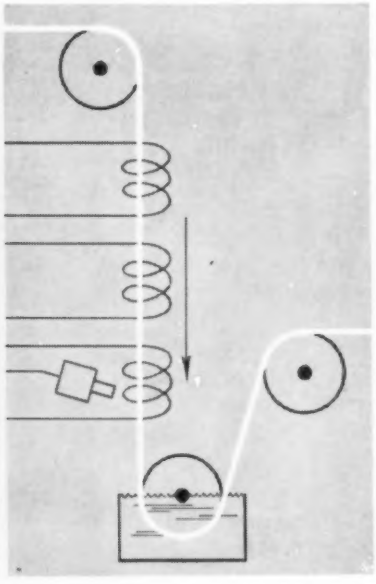
*WHERE **BIG** THINGS ARE HAPPENING **TODAY!***

ELECTROLYTIC TINNING LINE





Westinghouse 2400-kw oscillator equipment supplies high-frequency power to inductor coils. Generator output can be raised or reduced 90% in a couple of seconds.



Photoelectric scanner measures light reflection of passing strip, regulates radio-frequency power application in fraction of a second through saturable reactor.

WESTINGHOUSE EQUIPMENT SERVES THESE USERS

COMPANY	LOCATION	RATED LINE SPEED FPM	TIN FLOW EQUIPMENT
Jones & Laughlin Steel Corporation	Aliquippa, Pa.	600	600 kw, RF
Jones & Laughlin Steel Corporation	Aliquippa, Pa.	2100	1800 kw, RF
Republic Steel Corporation	Niles, Ohio	1000	1000 kw, RF
Republic Steel Corporation	Niles, Ohio	1400	1400 kw, RF
Steel Mill	California	1500	3000 kva, conduction†
Weirton Steel Company‡	Weirton, W. Va.	1300	1200 kw, RF
Weirton Steel Company	Weirton, W. Va.	1300	1200 kw, RF
Weirton Steel Company	Weirton, W. Va.	2100	2400 kw, RF
Weirton Steel Company	Weirton, W. Va.	2100	2400 kw, RF
Youngstown Sheet & Tube Company	Indiana Harbor, Ind.	600	600 kw, RF
Youngstown Sheet & Tube Company	Indiana Harbor, Ind.	2100	2400 kw, RF†

†Not yet in operation. ‡Division of National Steel Corporation.

Several other electrolytic tinning lines have Westinghouse conduction or radio-frequency reflow heating equipment, but line drives of another manufacture.

Westinghouse d-c motors withstand tough treatment because Bondite* and Bondar* insulations have twice the life expectancy of ordinary insulation. This means longer service from drive system, as well as the motors. *Trade-Mark

World's fastest tinning lines are Westinghouse-equipped

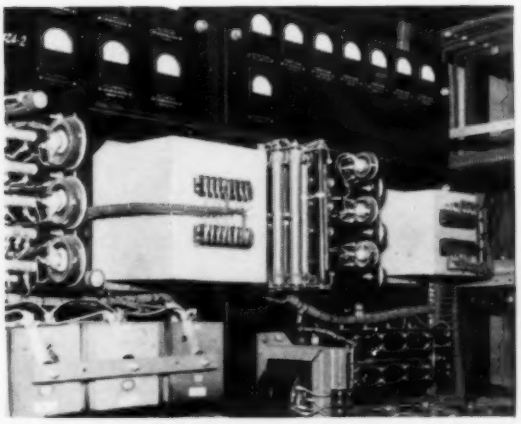
Engineering for electrolytic tinning lines is the most demanding in a steel plant, and Westinghouse pioneering in this field dates back to early attempts to deposit tin electrolytically on steel strip. Westinghouse has supplied all the electric line drive and tin reflow equipment for the higher speed horizontal acid type lines, and is now building equipment for the highest speed, vertical acid type.

The fastest tinning lines have as many as 150 individual d-c motor drives. Combining these drives, the generators that supply power to them, the 12 to 15 operators' stations, and the 100-foot-long controller into a coordinated drive system requires the kind of engineering and manufacturing talent Westinghouse can give you.

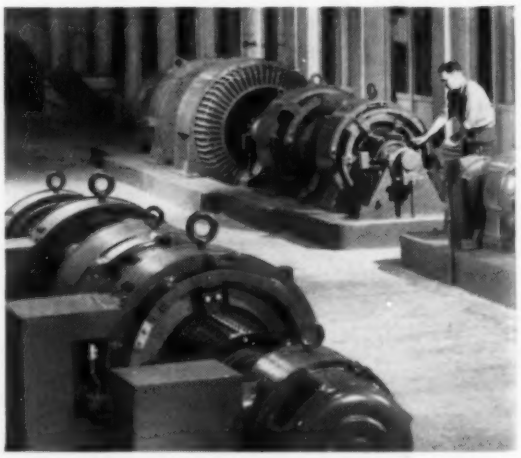
Reflow equipment, electro-cleaning and chemical treatment generators, switchgear, and numerous individual a-c motor drives and controls for pumps, scrubbers, welders and machinery adjustments must also be integrated into the system.

From planning to design, installation and start-up . . . Westinghouse brings decades of experience to you. A Westinghouse team will accept unit responsibility, and work with your engineering staff and consulting engineers in setting up your tinning line.

Contact your Westinghouse sales office for further details. Ask for a copy of B-6072, *Westinghouse Drives for Processing Lines.* Or write, Westinghouse Electric Corporation, 3 Gateway Center, P.O. Box 868, Pittsburgh 30, Pennsylvania.



Magamp regulators have no moving parts, brushes, commutators, bearings . . . bring outstanding precision, dependability to line drive control.

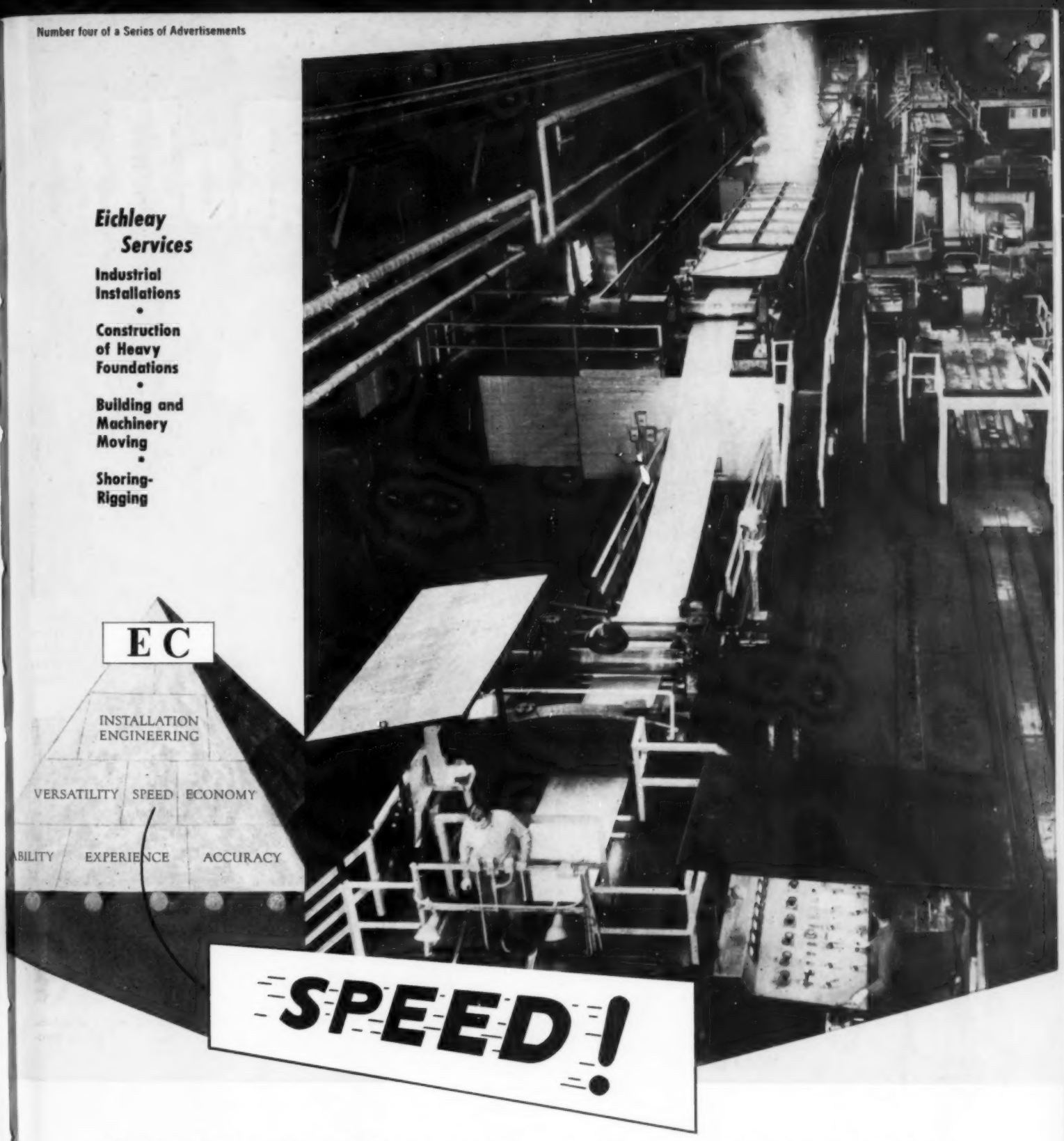


Westinghouse large motor-generator sets are built with Thermalastic® insulation which provides 20% greater dielectric strength, 10 times greater voltage endurance, 30 times greater tensile strength than ordinary insulation.

WATCH WESTINGHOUSE!

*WHERE **BIG** THINGS ARE HAPPENING **TODAY!***

Number four of a Series of Advertisements



Replacement of operating facilities is always a problem to an operating division. Lost production and disrupted operating schedules must receive primary consideration. These were the factors governing construction when Irvin Works replaced their 36″ continuous pickle line with new tanks, supporting structure, exhaust flumes, handrails, platforms, etc.

A ten day downtime had been allowed to take the old line out of operation and put the new line in. By assiduous use of pre-shutdown preparation time and by strict adherence to an Eichleay prepared construction schedule the downtime was cut by almost two full days.

Eichleay's methods enabled this unit to go back into operation on the ninth day. These same methods have accomplished other unusual installations in a safe, orderly, economic, efficient and speedy manner.

Write for Illustrated Booklet

Eichleay
ESTABLISHED 1875

CORPORATION

33 South 19th St., Pittsburgh 3, Pa.
1180 Richard Ave., Santa Clara, Calif.

Ohio Rolls

Chemically Correct Metallurgically Sound

Through the entire complex and exacting process of manufacturing OHIO ROLLS, Ohio's metallurgists, chemists, engineers and inspectors are continually analyzing, testing and inspecting. Their job is to make sure that every Ohio Roll meets exact specifications for metal analysis, hardness, tensile strength, dimension and finish. Ohio's quality control techniques and casting skills are your best assurance that Ohio Rolls deliver higher tonnage . . . give longer, more profitable service under critical operating conditions.

When you need rolls—large or small—call in your Ohio Roll Representative. He understands production requirements, and he can help you solve your roll problems quickly and efficiently.

OHIO ROLLS SERVE THE WORLD

shaping metal for all industry

Carbon Steel Rolls • Ohioloy Rolls • Ohioloy "K" Rolls • Ohio Double-Pour Rolls
Chilled Iron Rolls Denso Iron Rolls • Nickel Grain Rolls • Special Iron Rolls
Nioloy Rolls • Flintuff Rolls • Forged Steel Rolls

THE OHIO STEEL FOUNDRY COMPANY

LIMA, OHIO Plants at Lima and Springfield, Ohio

OR7

Industry News...

REPUBLIC TO INSTALL NEW ZINC PLATING LINE

▲ A new $4.5 million electrolytic zinc plating line will be installed at the Cleveland steel plant of Republic Steel Corp. for the production of Republic Electro Paintlok sheets. The line will have an initial monthly capacity of 10,000 tons which may be expanded to 12,000 tons monthly if desired.

To facilitate expansion, should it become desirable, handling equipment at the entry and delivery ends of the plating line will be set sufficiently far apart to provide for expansion of the line in between. Intermediate cleaning and plating equipment will be mounted on the shoe plates to facilitate rearrangement or future extension.

Equipment to be installed includes uncoiling machines, shears, welding machine, various cleaning and dip units, a coiler and auxiliary equipment.

The line will be able to handle steel coils weighing as much as 40,000 lb. Gages ranging from a minimum of .015 in. to a maximum of .105 in. and widths up to 60 in. will be produced. The finished product may be shipped in coils or cut to specified lengths and shipped as sheets.

J&L LICENSED TO MAKE AND MARKET SPIRAL NAIL

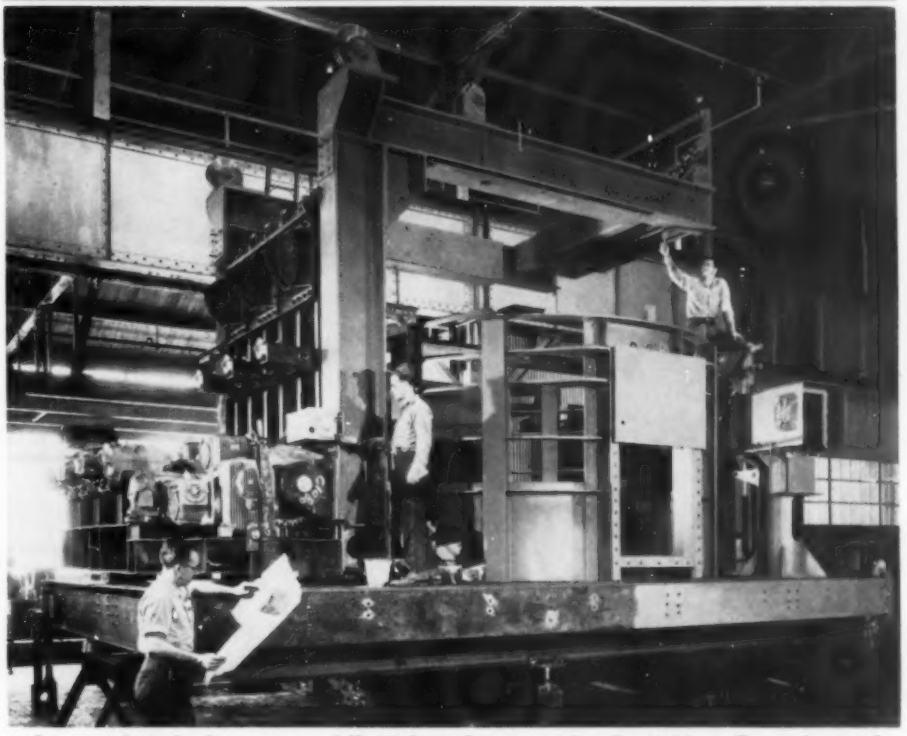
▲ The "Ardox" Spiral nail is now being manufactured and marketed in the United States by Jones & Laughlin Steel Corp. under a licensing agreement with The Steel Company of Canada, Limited, which developed the nail and process for producing it.

The threaded nail—which utilizes the same principle as the wood screw—has been recognized for some time by architects, contractors, carpenters, pallet makers, box manufacturers and others as having a superiority in holding power over common or straight-shank nails. However, its use had been restricted because of costly production methods. Each nail had to be threaded separately, or produced by twisting soft wire with subsequent heat treatment—an expensive process.

The process developed by The Steel Company of Canada, Limited, makes it possible to sell the Spiral nail at a lower price per nail than the common nail. By this new method stiff stock wire is pre-heated, then cut, pointed and headed into nails.

Because of this type of operation, the thread form goes right on up to the base of the head, greatly increasing the holding power, an important factor where high holding power is a necessity as in pallet manufacturing and for underlay flooring.

FURNACE READIED FOR SHIPMENT TO DUQUESNE WORKS



A new electric furnace rapidly takes shape at the Ambridge, Pa., plant of U. S. Steel's American Bridge Division slated for delivery to the corporation's Duquesne Works. The furnace shell is 12 ft in diameter and 10 ft deep, with a 15 ton capacity. The swing roof type furnace, when installed, will make the fifth in operation at the Duquesne plant.

ADDS TO FACILITIES AT RAVENSWOOD MILL

▲ Extensive facilities for the production of aluminum plate will be added to the sheet and foil rolling mill now under construction by Kaiser Aluminum and Chemical Corp. at Ravenswood, W. Va.

The additional facilities will include a new 144-in. plate mill, heat treating facilities and ultrasonic testing equipment as well as the world's largest plate stretcher, capable of stress-relieving aluminum alloy plate up to six in. thick.

For the Ravenswood mill, company engineers are developing designs for a stretcher which is expected to attain stretching capacity of 20 to 25-million lb. The new stretcher will be capable of handling a maximum cross-section of 550 sq in. Within this overall limit, gages up to six in. and widths up to 12 ft may be stress-relieved by stretching, and lengths up to 60 ft may be handled.

The plate will be rolled on the new 144-in. 4-high reversing mill to be installed and on the 168-in. 4-high reversing hot breakdown mill already scheduled for installation at Ravenswood. The latter mill will handle ingots weighing up to 10,000 lb.

A horizontal heat treating furnace capable of handling the largest plate to be produced will also be installed at the Ravenswood plant.

...and they get it with

Waldron
COUPLINGS

The motor driven boiler feed pump application pictured above needs a WALDRON coupling to make it a top engineering and mechanically perfect installation. That's why WALDRON is being specified by more and more pump and compressor manufacturers.

SHEAR PIN ... CUT-OUT ... FLOATING SHAFT ... SPACER ... OIL COLLECTOR
CONTINUOUS LUBRICATED ... PLUS OUR HS HIGH SPEED COUPLING

Complete details in Catalog 57

JOHN WALDRON CORP.
NEW BRUNSWICK • NEW JERSEY
Sales Representatives in Principal Cities
Export Agents • Frazar & Company, Inc.

GRANITE CITY BUILDS OWN GALVANIZING LINE

▲ Granite City Steel Co.'s first continuous galvanizing line has been designed and built by the company's engineering, operating and maintenance departments. The line was laid out to fit the requirements for producing "Strongbarn," the company's patented, high-tensile roofing and siding for farm, ranch and industrial buildings.

Geo. B. Schierberg, president and treasurer, said the line would enable Granite City to "substantially increase" its production of galvanized steel. Last year, it shipped 137,000 tons of galvanized and corrugated products.

Granite City Steel will continue to use the four galvanizing pots it has maintained for hot-dip galvanizing. Three will continue to handle light-gage galvanized products. The fourth is being converted for a new product for the company, galvanized culvert sheets for the fabricators of drainage culverts.

ANNOUNCE FORMATION OF WEST COAST FIRM

▲ The Herman-Ashby Co., a newly organized firm of manufacturers' representatives with offices in the San Francisco and Los Angeles areas, are covering the western states for Union Electric Steel Corp. (forged steel rolls), Smeeth-Harwood Co. (copper for blast furnaces), F. Tinker & Sons Co. (shear knives), S. P. Kinney Engineers, Inc. (blast furnace equipment), and Alliance Machine Co. (cranes, etc.).

Established by G. N. Herman, recently retired as Pacific Coast representative for Continental Foundry & Machine Division of Blaw-Knox Co., and R. A. Ashby, formerly with Lippincott Co., expect to add several other companies to the list they now represent.

LONGENECKER ASSOCIATES TO REPRESENT KOPPERS

▲ Koppers Co., Inc. announced that Longenecker Associates of Pittsburgh has been named representative for two major products of its Metal Products Division.

Longenecker Associates will repre-

New Automatic Precipitator Control by

WESTERN PRECIPITATION

offers many vital advantages...

1 LONG LIFE

This new control has indefinite life expectancy under all types of operating conditions. There are no tubes to replace, no high speed relays, counters, or timers to maintain. All circuitry consists of rugged "static" devices that have unusually long life!

2 RELIABILITY

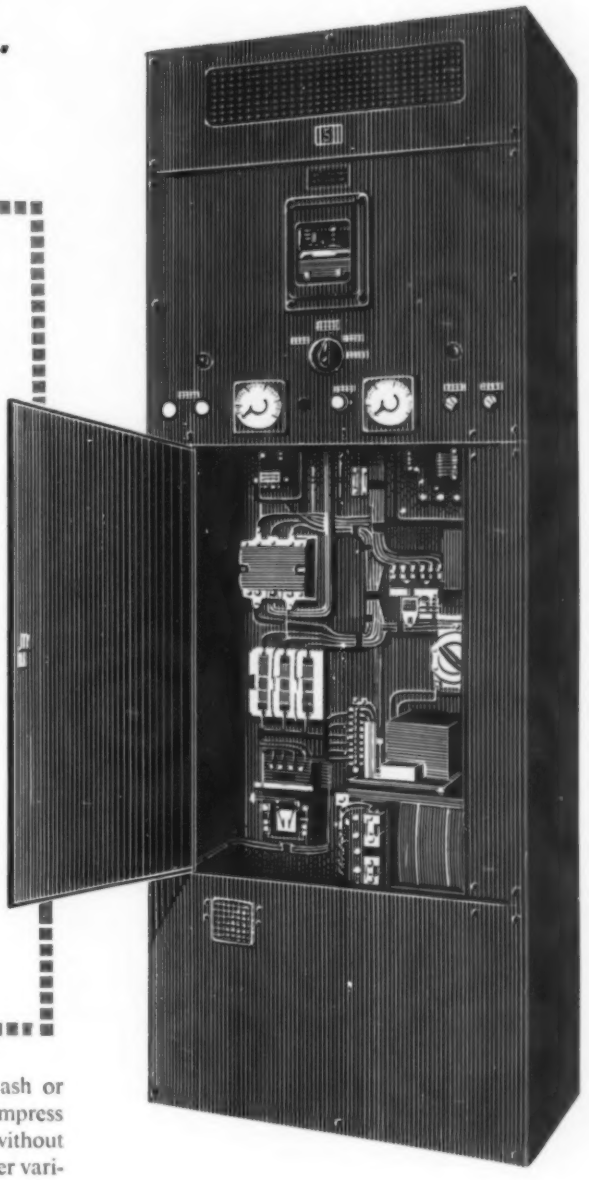
Optimum Precipitator power input is maintained regardless of operating conditions. The sensing control is simple, positive, accurate—and automatically evaluates the spark "Power Value" (intensity and frequency)—not just frequency or intensity alone.

3 STABILITY

Under short circuit, open circuit or other varying conditions, this control is completely stable and inherently trouble-free!

4 MODEST COST

Modest initial cost coupled with negligible maintenance assure optimum operating efficiency (therefore lower operating costs) throughout many years of continuous service.



WHEN using a Cottrell Precipitator for collecting dust, fume, fly ash or other suspensions from industrial gases, it is essential at all times to impress on the high voltage system the highest possible voltage and current without "flashover". Depending upon gas conditions, dust loading and other variable factors, the optimum voltage and current requirements vary widely from one minute to the next. Therefore, the vital importance of a simple, trouble-free and highly sensitive Precipitator Control is self-evident.

This new Western Precipitation Automatic Precipitator Control—*a product of the organization that has consistently led in the application of Cottrell Precipitators for industrial gas cleaning*—combines vital advantages found in no other competitive equipment. Our nearest representative will be glad to supply complete details. Or write direct!

Why not modernize your present out-dated Precipitator installation? The Western Precipitation Automatic Precipitator Control can be installed on any Cottrell unit. For further information contact our nearest office!

Western Precipitation Corporation

Designers and Manufacturers of Equipment for Collection of Suspended Material from Gases . . and Equipment for the Process Industries

Main Offices: **1067 WEST NINTH STREET, LOS ANGELES 15, CALIFORNIA**

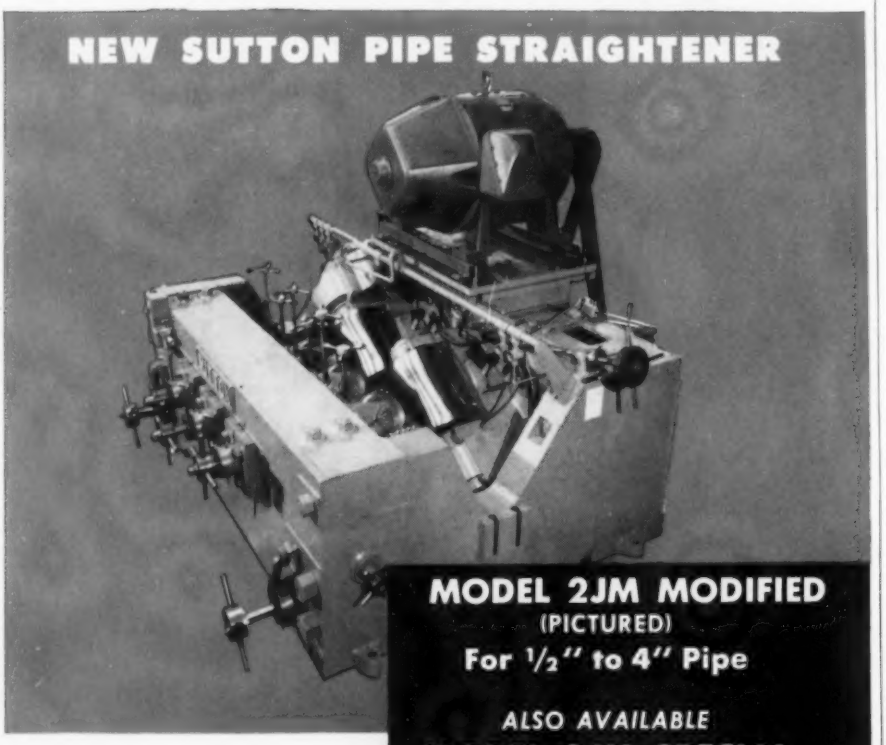
Chrysler Building, New York 17 • 1 North La Salle Street Building, Chicago 2 • Oliver Building, Pittsburgh 22 • 3252 Peachtree Road N. E., Atlanta 5 • Hobart Building, San Francisco 4

Precipitation Company of Canada Ltd., Dominion Square Building, Montreal

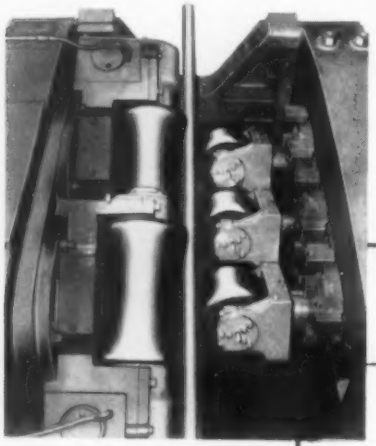
Representatives in all principal cities

COTTRELL Electrical Precipitators
MULTICLONE Mechanical Collectors
CMP Combination Units
DUALAIRE Reverse-Jet Filters
HOLO-FLITE Processors

STRAIGHTEN PIPE
AT 1000 FPM and FASTER!



Specifically designed to meet the demands of today's continuous-weld pipe mills for steady, dependable production at highest straightening speeds.



- DEPENDABLE SERVICE
- HIGH PRODUCTION
- QUALITY STRAIGHTENING
- EASY SCALE DISPOSAL

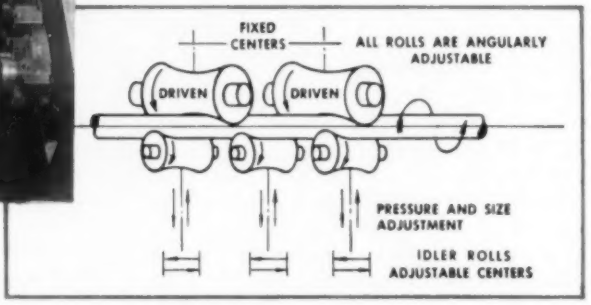


Photo and diagram of 5-roll design shows engineering principle of driven rolls with opposed idler rolls.

Ask for Bulletin No. 25

SUTTON Engineering COMPANY

Manufacturers for Ferrous and Non-Ferrous Metal Industries

STRAIGHTENERS, EXTRUSION PRESSES, HYDRAULIC STRETCHERS, SHEET LEVELERS, CONTOUR CORRECTING MACHINES, STRAIGHTENING PRESSES, ROTARY CLEANERS, HEAVY-DUTY UNIVERSAL JOINTS, ROLLS

FIRST NATIONAL BANK BLDG., PITTSBURGH 22, PENNSYLVANIA
PHONE: GRANT 1-8077 PLANT: BELLEFONTE, PA.

sent Koppers in the sale and promotion of Aeroturn dust filters and Koppers mechanical dust collectors in eastern Ohio, northern W. Va., and western Pa.

GAS TURBINE WILL USE EXHAUST HEAT BOILER

▲ The first steel mill gas turbine installation using a waste heat boiler has been ordered from the Westinghouse Electric Corp. by the Altos Hornos de Mexico steel mill at Monclava, Mexico.

The exhaust gas at 750 degrees F will be used in a waste heat boiler to generate steam which will drive a steam turbine. The steam turbine drives an air compressor supplying air for blast furnace blowing.

The 8100-kw gas turbine will operate at 4700 rpm and will consume 3,655,000 cu ft of natural gas daily. Gas will be supplied from a 200-mile pipeline. A gas turbine was chosen for expanded needs due to a limited water supply. One-third the amount of water required to operate a steam turbine is needed for a gas turbine of similar rating.

The unit is to be shipped from the company's steam division, Lester, Pa., early 1958.

REFRACTORIES PLANT ACQUIRED BY PORTER

▲ Robinson Clay Products Co.'s refractory plant and property at Alexandria, Pa. have been acquired by the Laclede-Christy Division of H. K. Porter Co., Inc.

The sales and operation of the plant will be combined with those of the Laclede-Christy Division. The new operation will be known as the Alexandria Works.

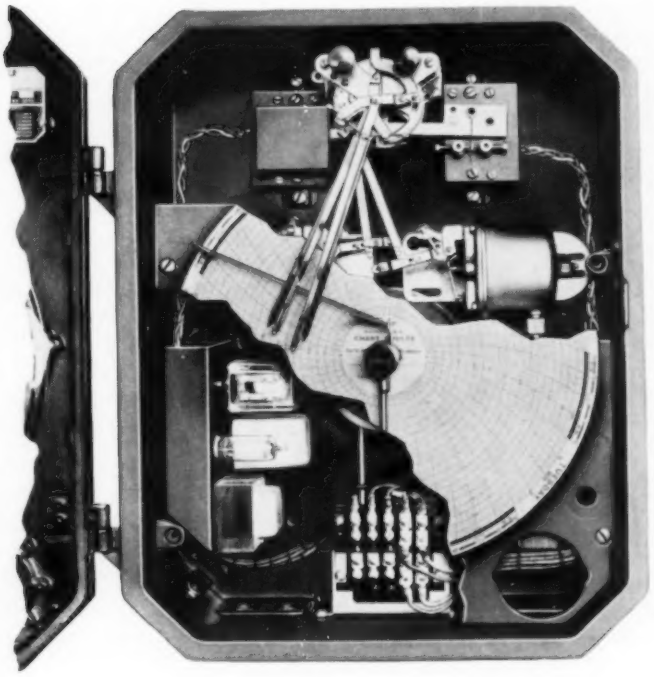
Laclede Silica Brick will be manufactured at this plant to provide Laclede customers in Eastern markets with improved service and delivery.

HOUSTON FIRM NAMED RUST AGENT IN TEXAS

▲ The firm of M. K. Griggs Co., Inc., Houston, Tex., will serve as Texas representative of the Rust Engineering Co.

As principals of the Houston firm, Mark K. Griggs, president, Burton W. Wallin, vice president, and James H. Lyman, sales engineer, will be ac-

NEW ELECTRONIC CONTACT CONTROLLER BY Taylor



FEATURES

- Changing Resistor-Capacitor Can gives Single Point or Differential Control. Control point easily adjusted by set pointer.
- Fully adjustable, self-locking differential between high and low contacts. Safe contact voltage—never over 6 volts. Current in micro-amps.
- Self-wiping control contacts made of non-corrosive Monel. All other parts are hermetically sealed against corrosion.
- Electronic tube, Relay and R-C Can are plug-in units. Load Contacts on Relay are Single-pole double-throw.
- Attachments can be fitted to present 100 Series Taylor Instruments with no drilling.
- Internal wires and external connections numbered for easy servicing. Signal lights and vibration damping available.

HERE'S rugged, positive contact action for control mechanisms of the two-position action type—the "on-offs", "open-shuts" and "high-lows". This new Taylor Electronic Contact Controller embodies a completely new concept in contact mechanisms—it's designed for:

1. Accurate and dependable operation of electrical circuits.

2. On-off applications with small process lags, slow reaction rates, and small and infrequent load changes.

3. Use on nearly all types of measuring systems—temperature, pressure, liquid level, flow, humidity, speed, etc.

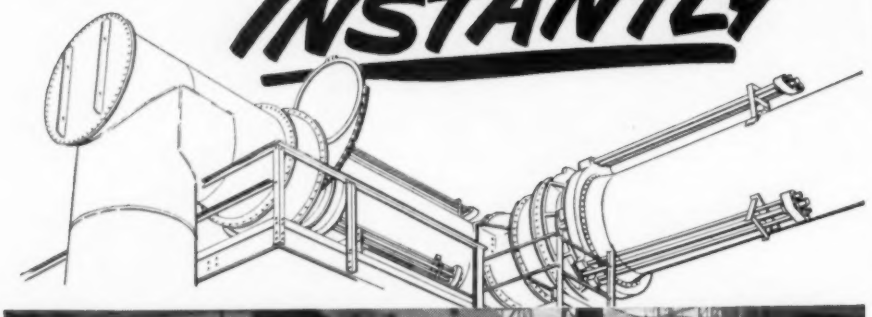
4. Indicating, recording and/or controlling purposes. An extremely versatile instrument, the new Taylor Electronic Contact Controller can be used in many different places where pneumatic facilities aren't advisable or available. It's made also for use as a supplement to pneumatic control.

These standard forms emphasize the flexibility of the instrument: Two-Position Single Point Action (On-Off), Two Position Differential-Gap Action (On-Off with adjustable differential gap or neutral zone), and Three-Position Differential Gap Action (High-Medium-Low, differential adjustable).

For full details ask your Taylor Field Engineer or write for **Bulletin 98265.** Taylor Instrument Companies, Rochester, N. Y., or Toronto, Canada.

Taylor Instruments
MEAN
ACCURACY FIRST
IN HOME AND INDUSTRY

HOW TO CLOSE LARGE GAS MAINS INSTANTLY



Bailey ENGINEERS

THERMAL EXPANSION GOGGLE VALVES

Bailey Mechanical Goggle Valves are produced in diameters from 6" to 72".

A powerful, completely dependable force of nature—the linear expansion and contraction of steel—is used to open and close gas mains equipped with these valves. When steam is applied to three sets of tubes they expand to separate the flanges, thereby freeing goggle plate for swinging to open or closed position.

Designed to protect men and equipment, Bailey Goggle Valves are safe and efficient on gas washers, blast furnace mains, precipitators and boiler plants. Diameters range from 36" to 120".

WILLIAM M. Bailey COMPANY
ENGINEERS
LEADERSHIP THROUGH QUALITY
1221 BANKSVILLE ROAD PITTSBURGH 16, PA

tive in all phases of Rust's industrial sales operations. The area served by the Griggs Co. will include the entire eastern half of Texas.

SIGNS AGREEMENT WITH GERMAN FIRM

▲ Blaw-Knox Company and Fried. Krupp of Essen, Germany, have entered into an agreement to exchange technical information in the development of sales and in the production of ferrous and non-ferrous rolling mills in countries outside the United States and Canada.

Signing of the agreement, which followed several months of negotiations, was jointly announced today by W. Cordes Snyder, Jr., president of Blaw-Knox, and Berthold Beitz, chief executive officer of Fried. Krupp.

The agreement, the announcement states, "will permit both companies to better meet market requirements for rolling mills in countries interested in greater self-sufficiency in steel and non-ferrous production." The technical data to be furnished by Blaw-Knox covers the company's Lewis and Continental mills.

WATERBURY-FARREL ACQUIRES ARMZEN CO.

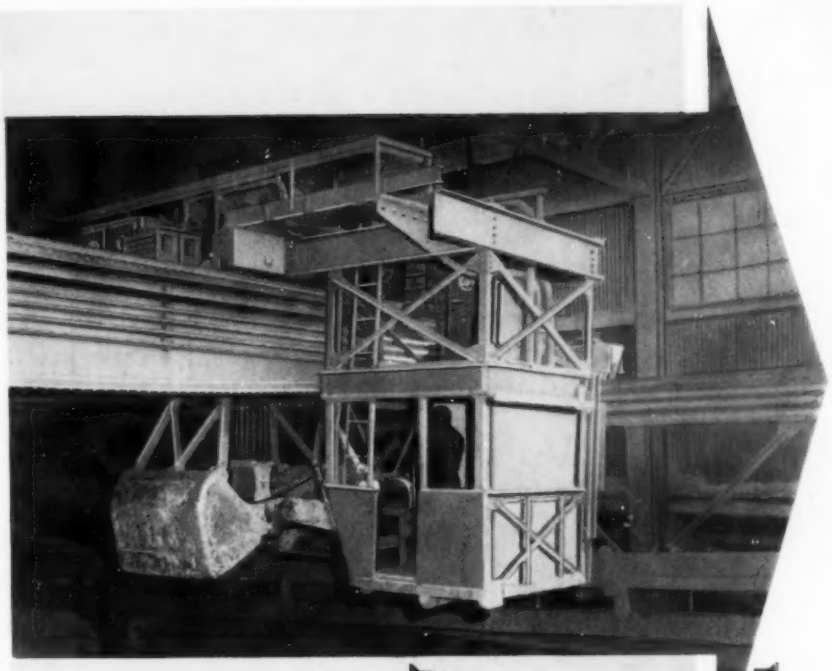
▲ The Waterbury Farrel Foundry & Machine Co. has acquired the Sendzimir Cold Mill interests of the Armzen Co. The staff of Armzen Co. has joined Waterbury Farrel, and T. Sendzimir will be manager of this new division.

Under the terms of the acquisition, Waterbury Farrel has assumed all obligations of Armzen with respect to existing cold mill contracts.

BLAST FURNACE MARK BROKEN AT REPUBLIC

▲ Republic Steel Corp. broke its monthly blast furnace production record in October when it produced 659,600 tons of pig iron, T. F. Patton, president, announced. The new mark was nearly 14,000 tons better than the old peak of 645,700 tons reached in May, 1956.

Previously the company had announced that it expected to set a new steel production record in October. Production actually rose to 941,800



CHANGE-OVER TO

EC&M

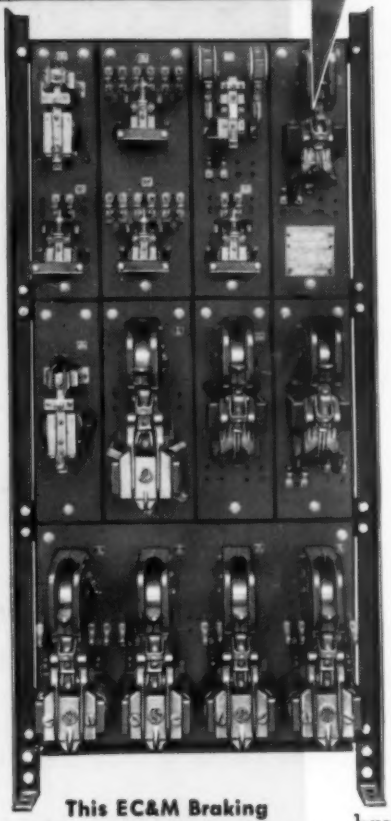
DYNAMIC BRAKING CONTROL

RESULTS IN

Safer, Smoother Operation

OF BUCKET CRANES

Dynamic Braking Bridge-Stop Control provides an all-electric braking system in which *the driving motor also acts as the braking motor.* Operator applies normal stopping by means of a 2-position foot switch which gives two points of dynamic braking depending upon the speed of the crane and the accuracy of stopping desired. Should power fail, dynamic braking is automatically applied to bring the crane to rest quickly, regardless of the position of the master switch.



This EC&M Braking Panel replaces all mechanical braking devices in southern fertilizer plant and operates satisfactorily in severe acid atmosphere

Something had to be done!

One of the cranes in this plant had partially jumped the runway when power failed at the instant of plugging. Ordinary braking methods failed. Magnetically-released, mechanically-set brake wore down rapidly under hard service. Motor burnouts, shaft and gear failures spelled costly delays. Repairs were a nightmare.

So a change-over was made to all-electric braking. Costly production delays were eliminated. Maintenance became merely routine inspection of motors and controllers. Operation became 100% satisfactory. And the operators warmed up to the smoother stopping.

Dynamic Braking Bridge-Stop Control offers advantages for your cranes. Write us for a copy of Bulletin 921-6.0. It tells how and why.

SQUARE D COMPANY

EC&M DIVISION • CLEVELAND 28, OHIO

7409

IMPULSE RUNNER

DURALOY

It's a 7 ton 18-8 Casting designed to handle acidulous water

With our battery of large electric furnaces and our large modern well equipped molding department, castings of this size are quite common in our production schedule.

Yet, if you require it, we can produce castings as light as only a few ounces. In fact, with our shell molding department we can produce in quantity very small pieces of any high alloy analysis desired.

Experience? Well, our work with static high alloy castings goes back to 1922 and with centrifugal castings back to 1931. This long experience is your assurance of a sound casting correctly alloyed.

THE DURALOY COMPANY

OFFICE AND PLANT: Scottdale, Pa.
EASTERN OFFICE: 12 East 41st Street, New York 17, N. Y.
DETROIT OFFICE: 23906 Woodward Avenue, Pleasant Ridge, Mich.
CHICAGO OFFICE: 332 South Michigan Avenue

tons of steel ingots during the month, approximately 12,000 tons more than the previous peak of 929,900 established in March, 1953.

At the Cleveland steel plant, new peaks in both steel and pig iron production were achieved. The district's six blast furnaces turned out 203,600 tons of pig iron last month compared with 202,000 tons in May, 1956, the previous record month.

Steel production in the district's nineteen open hearth furnaces rose to 245,800 tons, some 5,000 tons more than the previous record of 240,800 tons set in March of this year.

MANNESMANN-MEER OPENS NEW YOUNGSTOWN OFFICE

▲ Mannesmann-Meer Engineering and Construction Co., Inc. has opened a district office in Youngstown, Ohio.

The new office will be under the direction of Lothar S. Heym, newly appointed Youngstown district engineer, and will supplement the engineering and technical facilities of the company's headquarters staff at Easton, Pa.

KAISER DEDICATES NEW REFRACTORIES PLANT

▲ A new basic refractories plant of Kaiser Aluminum & Chemical Corp.'s Chemicals Division was dedicated at Columbiana, Ohio on September 29. The $5,000,000 facility, which has been under construction for a little more than a year, has commenced operations and is now supplying basic refractory brick, ramming mixes and furnace grains to the steel, cement, glass and copper industries in the East and Middle West.

This strategic location, close to the geographic center of the nation's great industrial areas, will permit improved service to eastern and midwestern customers who previously were supplied from Kaiser's Calif. facilities. The new plant will shorten delivery time in some cases by as much as 14 days.

The plant covers more than three acres and is located on a 185-acre site on the main line of the Pennsylvania railroad and within a few miles of the Ohio-Pennsylvania Turnpike.

(*Please turn to page 187*)

IN JAPAN

NEW Bliss reversing mill doubles in sheet steel and tin plate

This new four-high reversing mill at Yodogawa Steel Works is another example of how Bliss can engineer equipment to meet a special operating need. This ability...and the policy from which it stems... are important reasons why Bliss has grown to be a leading builder of rolling mills and mill equipment in little more than a quarter of a century.

Dual roll coolant systems make it possible for Yodogawa to roll either steel sheet or tin plate. The two systems provide a quick, easy change-over from the water soluble oil solution needed for sheet products to palm oil for tin plate products.

The mill itself is a 16″ and 53″ by 54″ capable of rolling strip up to 48″ in width at a maximum speed of 2012 feet per minute. The tension reels of its coil handling equipment can accommodate 20″ I.D. by 56″ O.D. coils weighing 30,000 pounds. The work rolls are alloy forged steel, while the backing rolls are Technalloy steel cast by Bliss' Mackintosh-Hemphill Division.

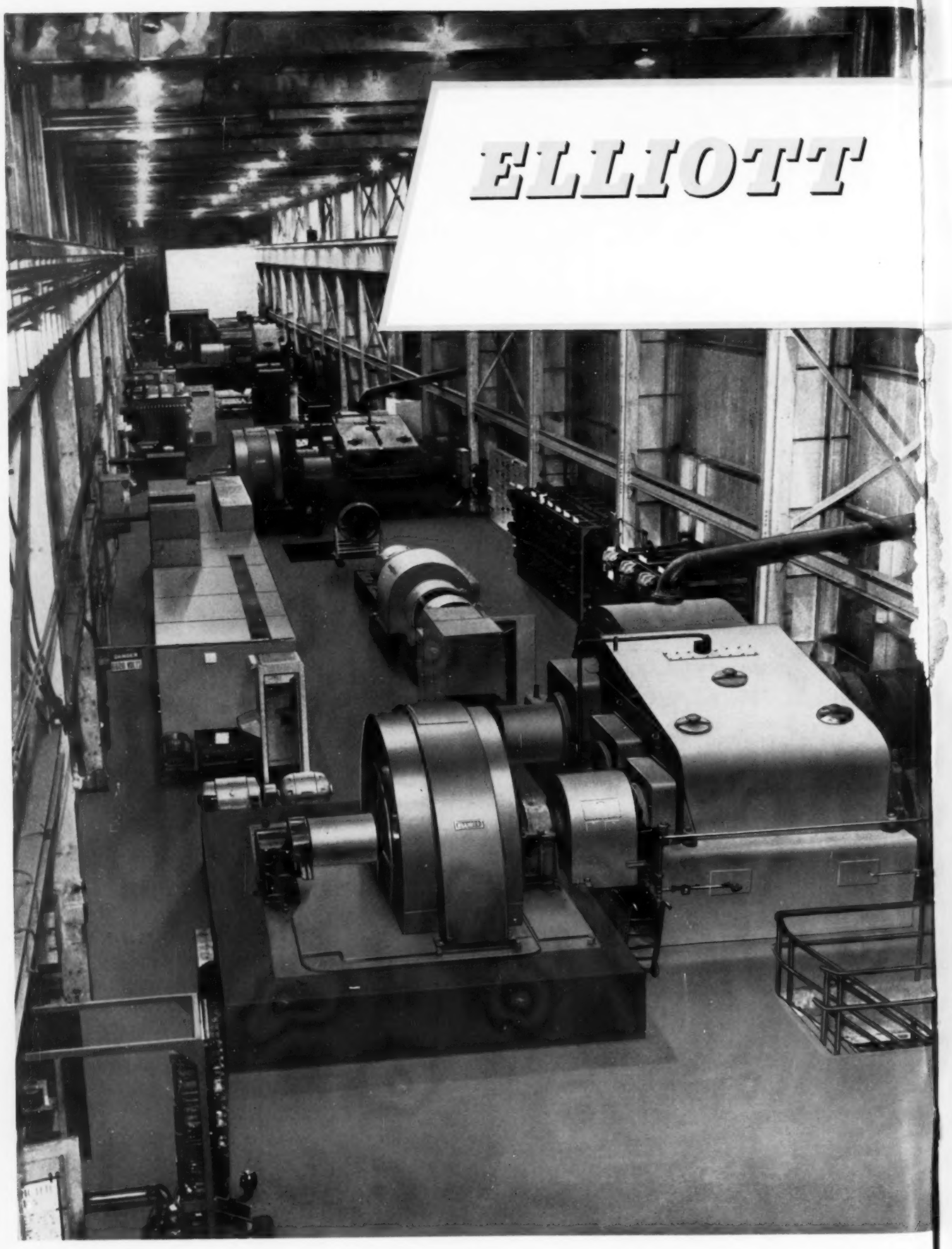
To gain an idea of what Bliss can do to help solve your particular rolling problem, write us today for a free copy of our 60-page Rolling Mill Brochure, Catalog 40-A.

E. W. BLISS COMPANY
General Office: Canton, Ohio
ROLLING MILL DIVISION
SALEM, OHIO

PLANTS: Canton, Cleveland, Salem and Toledo, Ohio; Detroit and Hastings, Michigan; Pittsburgh and Midland, Pennsylvania; San Jose, California. *In Europe:* E. W. Bliss (England) Ltd., Derby; E. W. Bliss Co. (Paris), France.

BLISS SINCE 1857

is more than a name... it's a guarantee


ELLIOTT

6000-Horsepower SYNCHRONOUS MOTORS

drive new roughing stands in Weirton's 54-inch hot strip mill

FOR DRIVING three roughing stands in the new 54-inch hot strip mill at Weirton Steel Company, a division of National Steel Corporation, Elliott 6000-horsepower synchronous motors were chosen. These motors, which are the largest in the mill, provide exceptionally high pull-out torque. An ingenious feature of the application is the Elliott mechanical "inching drives," which, by applying new principles to an old problem, facilitate fast and economical roll removal and replacement.

The steel industry uses many Elliott steam and electrical products, and they are all represented at Weirton. Large and small motors, strainers of various capacities, blast furnace compressors, steam turbines and condensers, deaerating heaters are among the items supplied to Weirton during the past 40 years.

For complete information on Elliott steel mill equipment, get in touch with the nearest Elliott District Office, or write Elliott Company, Ridgway, Pennsylvania.

FASTEST OF ITS SIZE

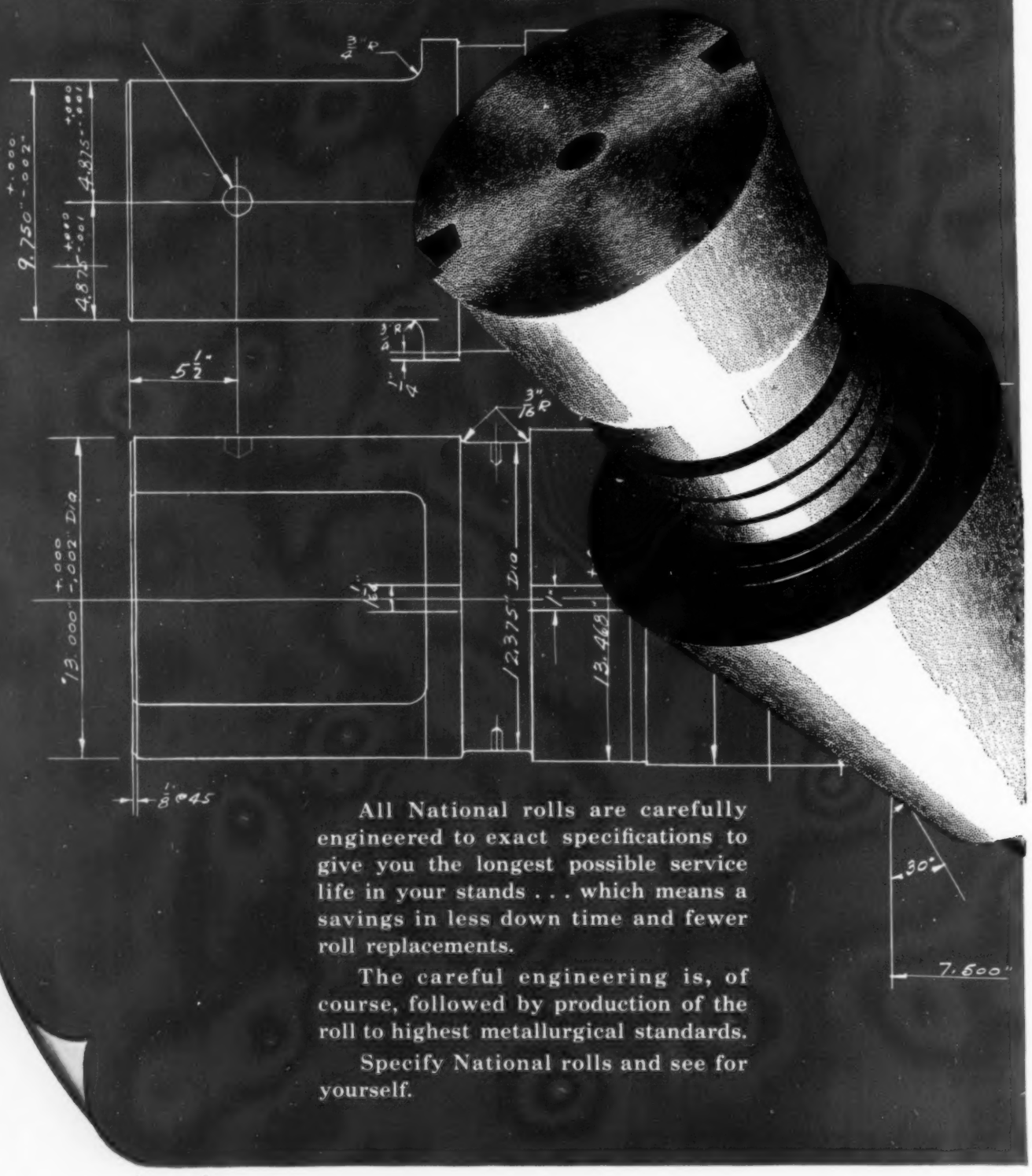
Shown above is one of the three 6000-hp, 450-rpm, 6900-volt Elliott motors which drive the new roughing stands of the modernized Weirton 54-inch hot strip mill—the fastest of its size in the industry.

ELLIOTT Company

STEAM TURBINES • MOTORS • GENERATORS • DEAERATING HEATERS
EJECTORS • CONDENSERS • CENTRFIGUAL COMPRESSORS • TURBOCHARGERS • TUBE CLEANERS • STRAINERS

R6-25

ENGINEERED FOR ECONOMY



All National rolls are carefully engineered to exact specifications to give you the longest possible service life in your stands . . . which means a savings in less down time and fewer roll replacements.

The careful engineering is, of course, followed by production of the roll to highest metallurgical standards.

Specify National rolls and see for yourself.

THE NATIONAL ROLL & FOUNDRY CO.

(A Wholly Owned Subsidiary of General Steel Castings Corporation)

Avonmore (Westmoreland County) Pennsylvania

Specialists in Iron, Alloy Iron and Steel Rolls, Carbon, Alloy and Manganese Steel Castings

(*Continued from page 182*)

Included are facilities for receiving and storing raw materials; grading, drying, classifying and mixing ingredients; pressing, drying and burning brick, and checking and shipping finished product. Other facilities include an extensive laboratory for quality control, machine shop for servicing the plant and a separate administration building.

When additional equipment now on order is installed by the end of this year, the plant's annual capacity for basic brick, aside from ramming mixes and furnace grains, will be 48,000 tons.

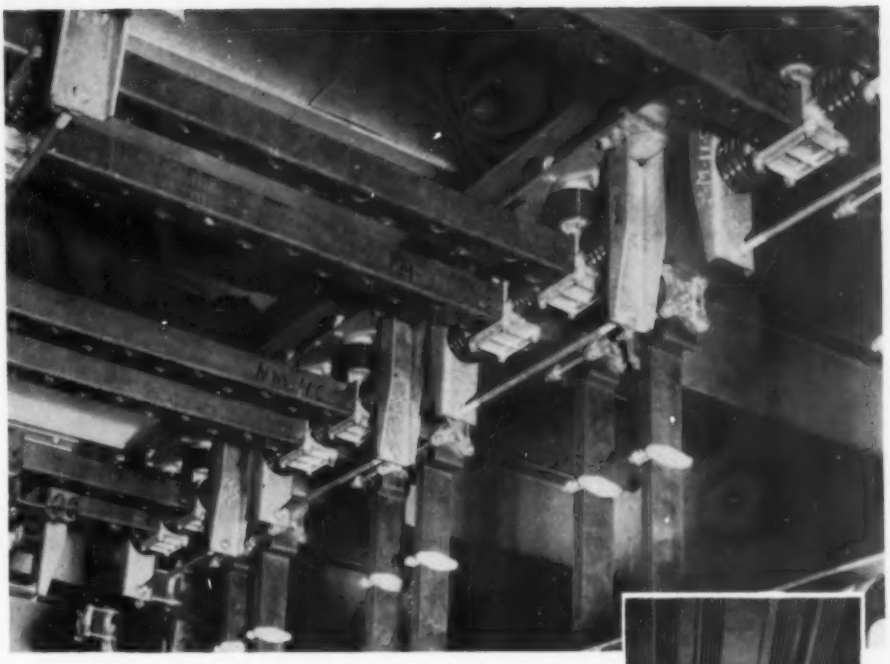
Periclase, which is high-purity calcined magnesia, is the basic raw material for the high temperature refractory products produced at Columbiana. This is being supplied from Kaiser Chemicals Division's fully integrated raw materials plants in Calif. Chrome ore, another important ingredient of some of the basic refractory products, is imported from the Philippine Islands.

CONTRACT FOR SKIN PASS MILL AWARDED TO MESTA

▲ The Mesta Machine Co. has been awarded a contract covering the design and manufacture of two 48 in. two-stand tandem four-high skin pass mills. The installation will be made at the Sparrows Point, Md., plant of the Bethlehem Steel Co. and will skin pass cold reduced, annealed steel strip in tin plate gages.

This mill, driven by 4,333 hp, will be geared for a maximum speed of 4,500 fpm. The equipment will include entry and delivery conveyors, each approximately 25 ft-0 in. long; cone type feed reel at the entry side; and a tension reel with an elevating coil stripper at the delivery side of the mill. This mill, designed to process strip steel with a maximum width of 44 in., will handle coils 56 in. diameter weighing 600 lb per inch of width.

In addition to the above, a contract has been awarded to Mesta for additions to an existing 56 in. single stand skin pass mill, as well as the design and manufacture of a new 56 in. skin pass stand to make a two-stand tandem four-high skin pass mill by using an existing single stand mill. This mill will be designed for



Avoid Costly Down Time

with DELTA-STAR reinforced

BUS STRUCTURES

When properly designed, bus structures can be relied on to withstand severe short circuits without damage. Delta-Star reinforced bus structures are engineered to withstand the maximum forces that may be encountered, consistent with the capacity of your system. Extra strength is built in by using heavy reinforced construction with high grade wet process porcelain placed in compression, taking full advantage of the porcelain's greatest strength.

Delta-Star engineers will be glad to work out your bus problems and develop a layout to suit your specific requirements.

OTHER DELTA-STAR PRODUCTS
Used in Mills and Industrial Plants

- Crane Rail Supports
- Disconnecting Switches
- Terminators (Potheads)
- Plugs and Receptacles
- Spool Insulator Cable Supports
- Water Cooled Conductors and Fittings
- Interrupter Switches
- Power Connectors

DELTA-STAR ELECTRIC DIVISION

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NEW GAMMA RAY
QUALITY CONTROL
on master, joiner and end links
makes TM
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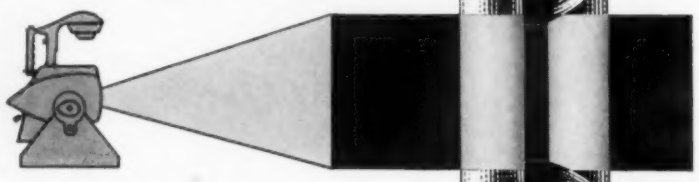
ALLOY SLING CHAINS
the PREFERENCE wherever
PLANT SAFETY... LOW MAINTENANCE
and FEWER REPLACEMENTS are factors!



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Call your DISTRIBUTOR today for all the facts and complete specifications!

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S. G. TAYLOR CHAIN CO., INC.
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skin passing carbon steel strip with a maximum width of 52 in. in tin plate gages and in sheet stock of light gages, at speeds up to 3,200 fpm. The coil feeding equipment will be suitable for handling strip steel coils about 70 in. in diameter, with maximum weights up to 50,000 lb.

Mesta will be responsible for the complete layout, will make all the engineering details required for the construction of foundations and electrical systems and will supervise the work of installation in the field.

NEW GE TEST BUILDING UNDER CONSTRUCTION

▲ General Electric Co.'s Large Steam Turbine-Generator Department announced it has started construction of a $2,500,000 "Overspeed Test Facility."

The new test building will occupy some 8700 sq ft of space and will be used to spin steam turbine rotors and generator rotors—which can weigh as much as 185 tons—at some 170 to 200 per cent above their normal speed of rotation. The test facility will be used to evaluate the effects of abnormally severe operating conditions on the material properties and design features of the rotors during their performance.

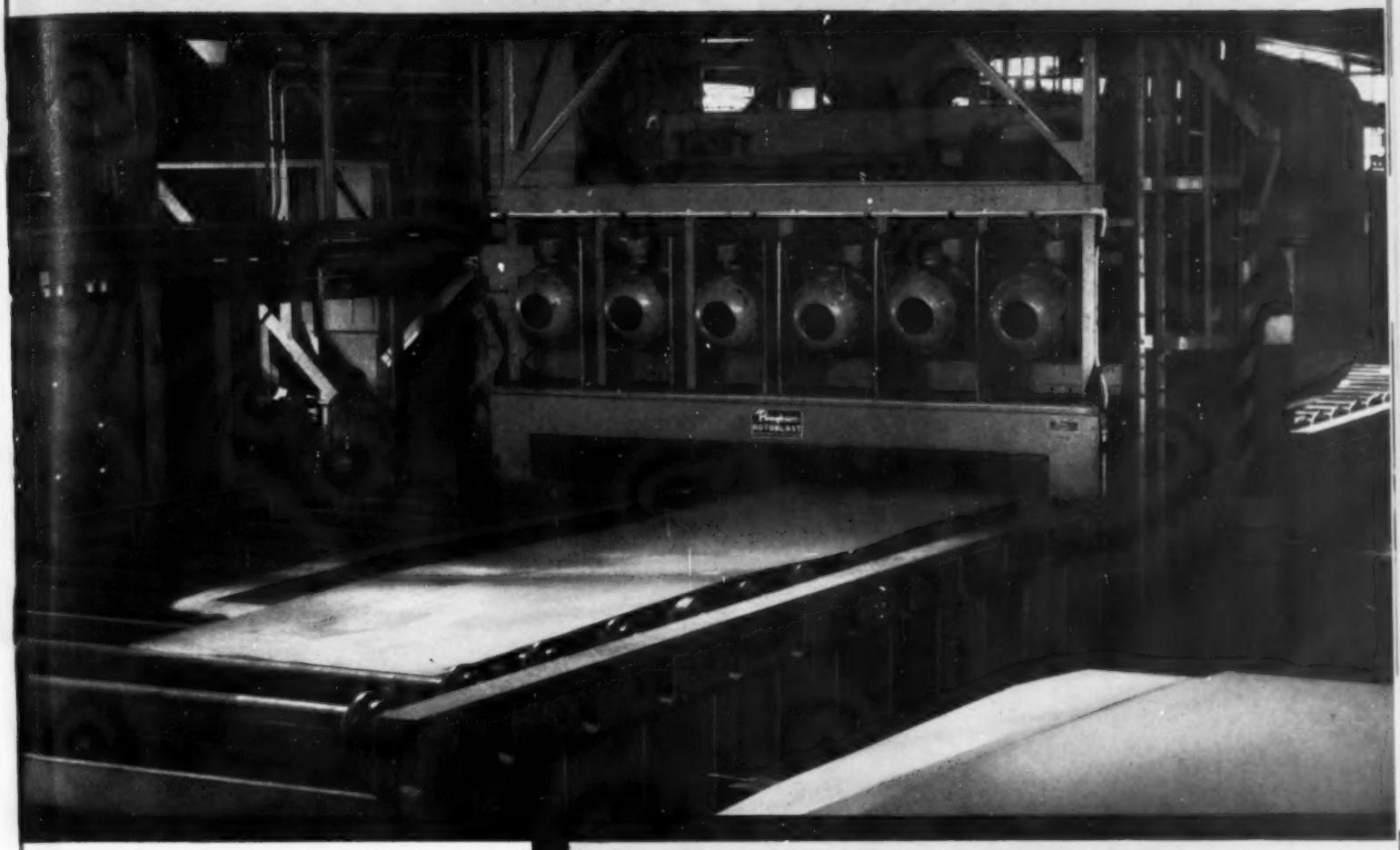
Construction has been started in an area close to the Department's turbine-generator development laboratory at GE's Schenectady plant. The test facility is expected to be completed and ready for operation by mid-1957.

ANNOUNCES PURCHASE OF DAVIES LABORATORIES

▲ The purchase of Davies Laboratories, Inc., of Beltsville, Md., manufacturer of specialized high-speed data recording systems, has been announced by Minneapolis-Honeywell Regulator Co.

Davies Laboratories was formed in 1946 by Gomer L. Davies, who has been its president since that time. The company, which recently occupied a new plant in Beltsville, will continue operations there under Davies as general manager. Henry F. Dever, vice president of Honeywell and head of its Industrial Division, will assume corporate direction of the operation.

Descale steel sheets, plates, coils

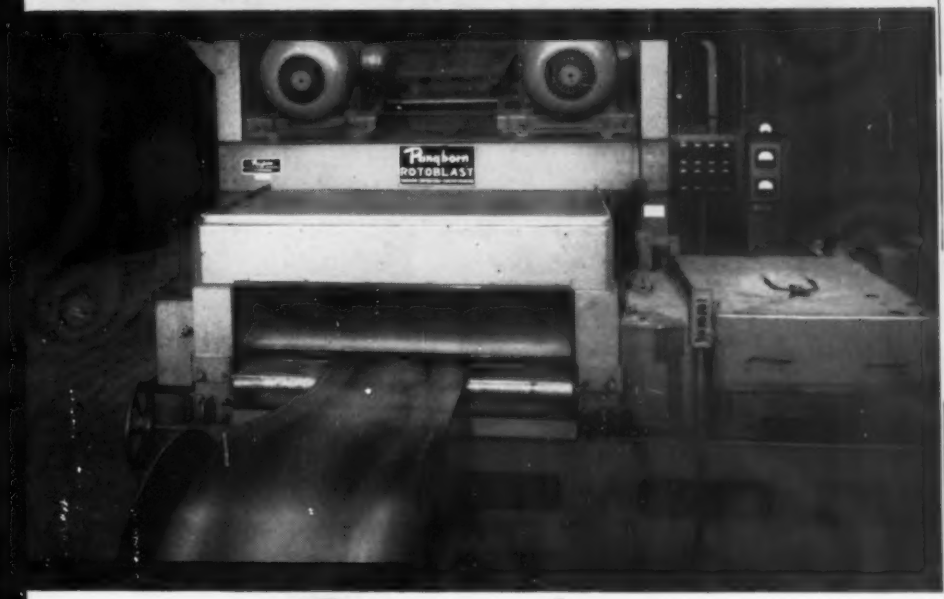


No more scale breaking or pickling! No more acid disposal problems! Pangborn Rotoblast Descaling Machines descale steel sheets, plates and coils, and they operate at big savings over pickling costs!

How? They work quickly. They clean thoroughly. They're a one-man operation. Unlike acid baths, they can be located near your production, cutting handling costs. And they save floor space, require much less room than vats. Available in a variety of models, Pangborn Rotoblast Descaling Machines handle steel sheets, plates and coils of any thickness, width and length. If you want to cut descaling costs to the bone, investigate Pangborn Descaling Machines!

For complete information, send for Bulletin 608. Write: PANGBORN CORPORATION, 4400 Pangborn Blvd., Hagerstown, Maryland.

at *less than half the cost*



*U. S. Pat. # 2184926 (other patents pending)

with Pangborn Rotoblast® Descaling Machines!

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3 BS

BLAST CLEANS CHEAPER

Rotoblast Blastmaster® & Continuous-Flo Barrel

Rotoblast Tables & Table-Rooms

Special Blast Rooms & Cabinets

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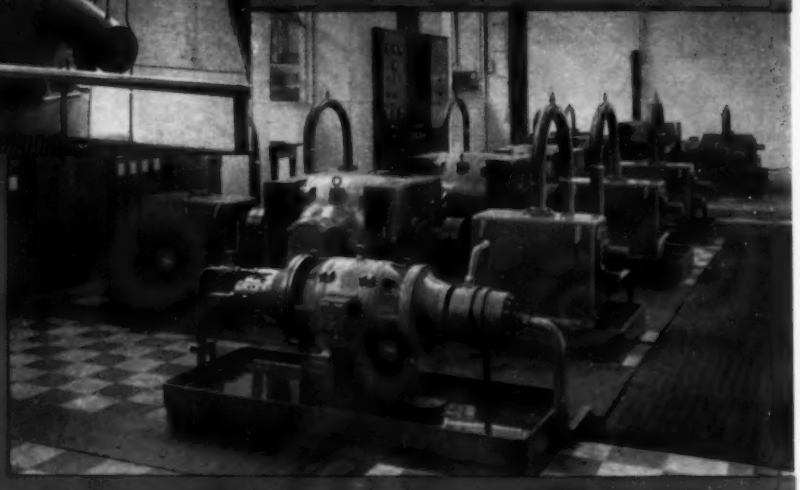
SCHLOEMANN

This automatic, self-contained oil-hydraulic extrusion press for tubes and rods, power 700/780 tons, produces up to 60 light metal tubes per hour.

Self-contained oil-pump drive for automatic 700 ton vertical tubing and rodding press, and horizontal 1,650 ton press.



Vertical oil-hydraulic extrusion press for tubes and rods

Tubes, hollow sections and rods can be extruded in automatic operation by several methods.

Far-reaching automation permits a high rate of production.

Automatically attained uniform extrusion speed results in a uniform quality of products.

Easily adjustable guides assure even wall-thickness of tubes; mandrels used for hollow sections can be easily adjusted and securely held in position to conform with the die opening.

FELLER ENGINEERING COMPANY
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Bearings

With one of the largest and most diversified stocks of bearings in the U.S.A.--Berry can make immediate delivery of practically any type or size of bearing needed. All famous brands included. Expert bearing engineering service is available, too. These are the reasons why Berry Bearing Company is "bearing headquarters" for the great Chicagoland industrial area...and...has been--since 1920. For whatever you require in bearings--call Berry. No obligation, of course.

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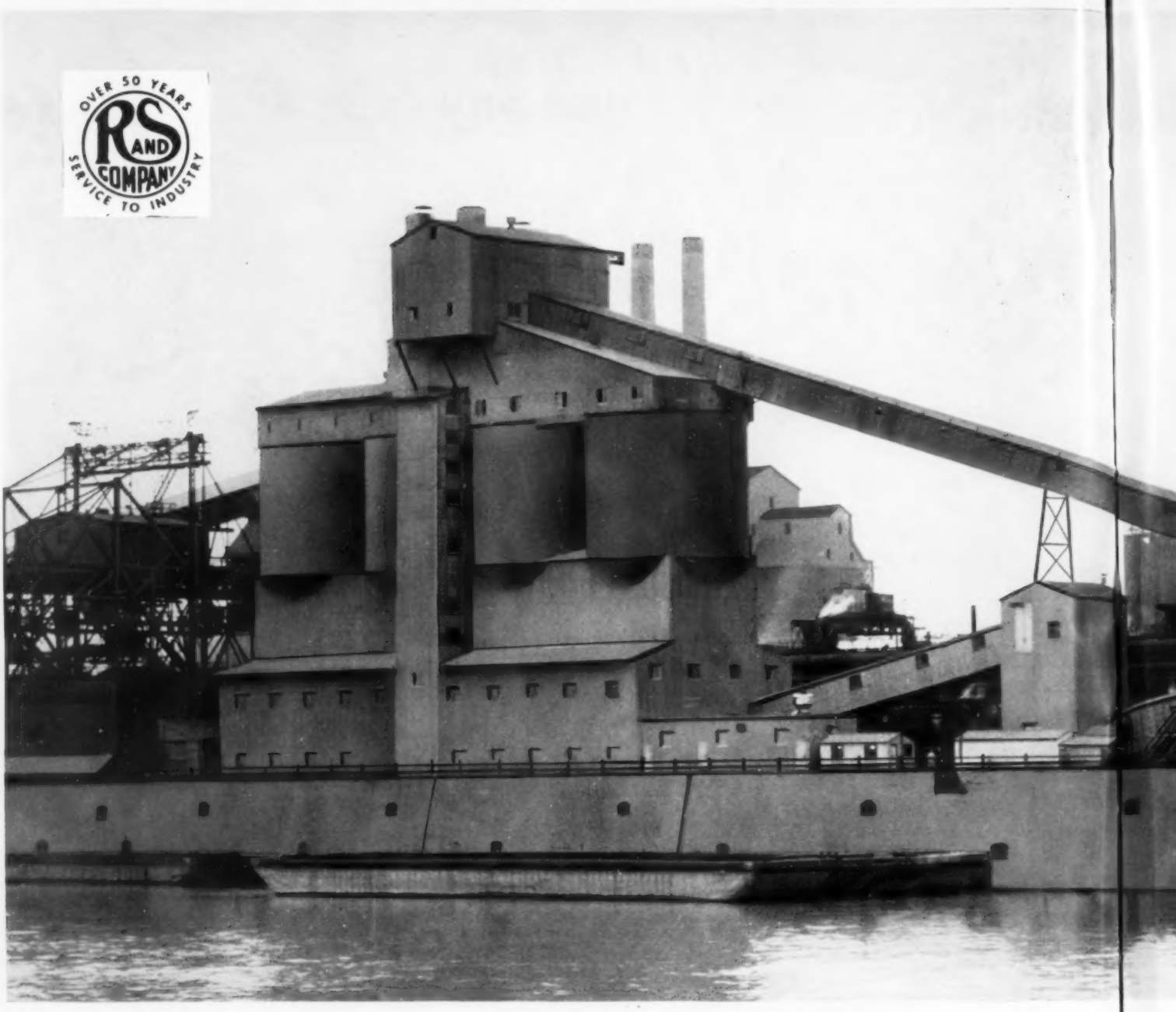
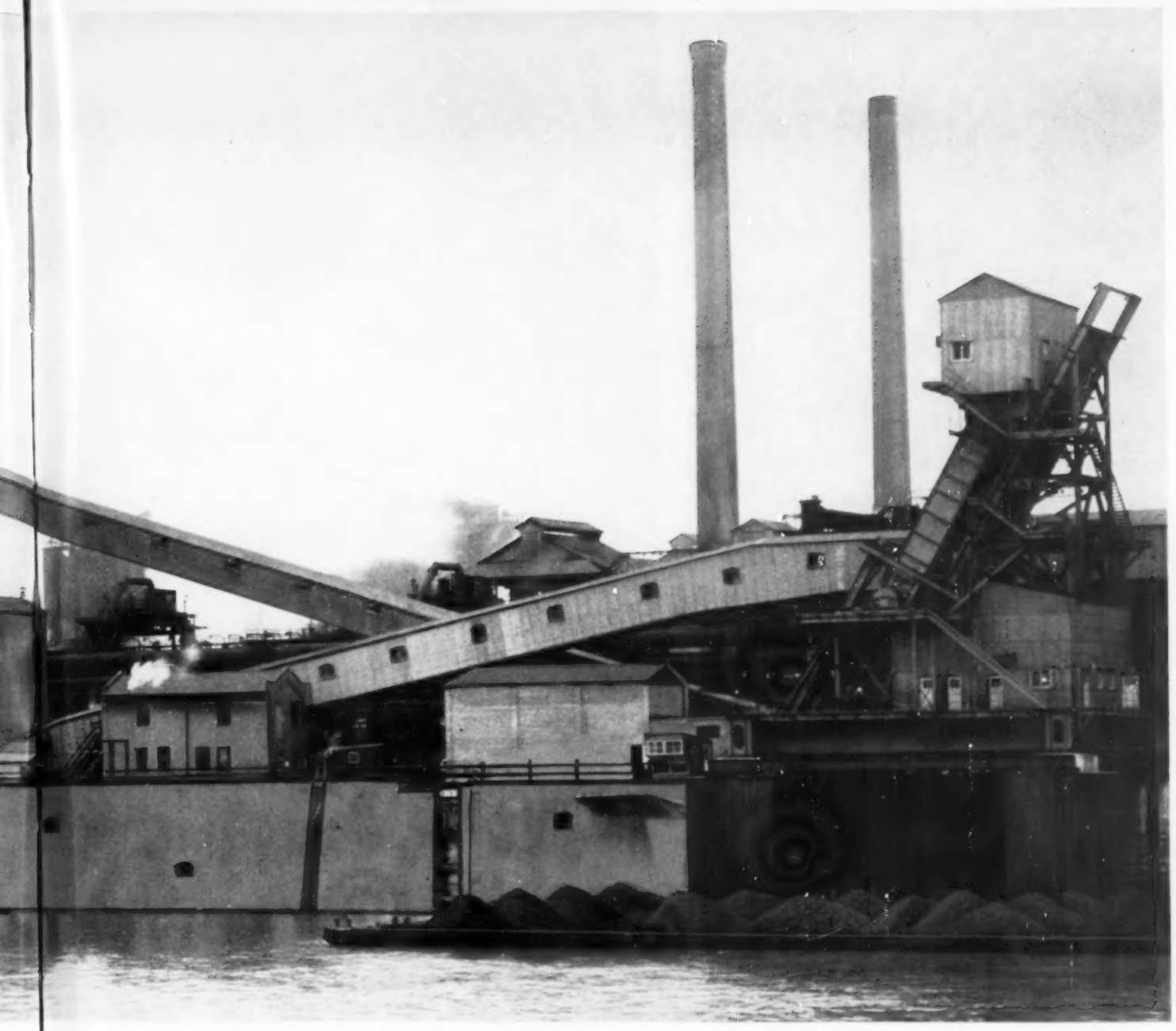


2000 TONS OF

—from Barges—to Blending

An integrated Material Handling System for continuous-flow operation which utilizes a 3-bucket type barge unloader and a belt conveyor system with scales, crushers and samplers for blending coal, including transfer conveyors with galleries for delivery to the storage bins of coke oven batteries.

Engineering—Construction—Fabrication—*ONE CONTRACT—ONE RESPONSIBILITY*



COAL PER HOUR

Bins—to Coke Ovens

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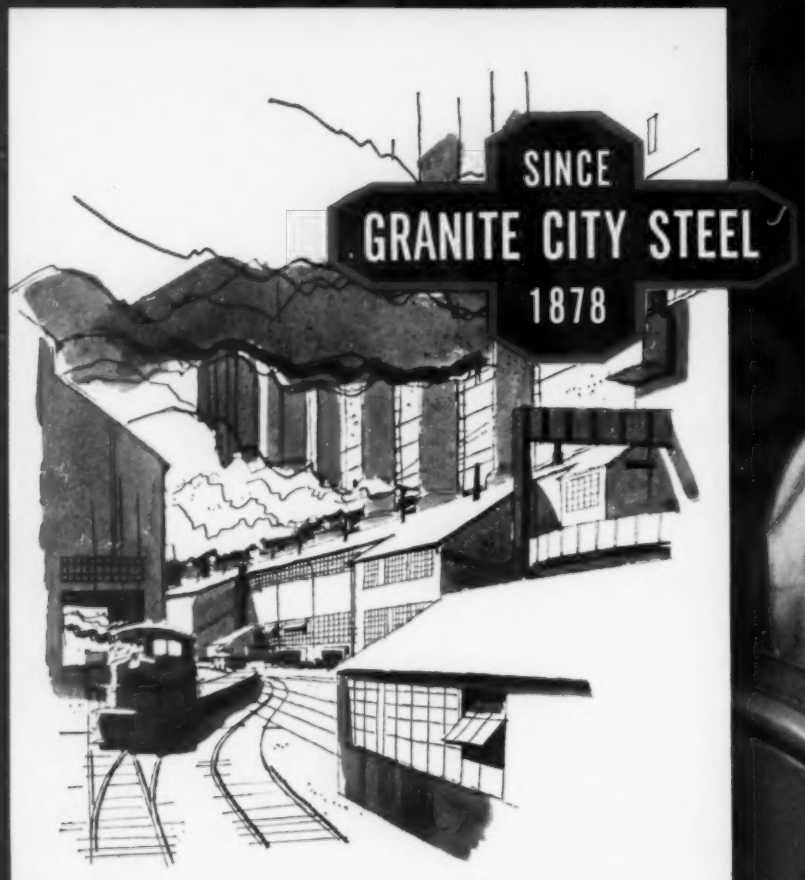


GRANITE CITY STEEL COMPANY...

"Keeps Rollin' Along"

And Allis-Chalmers steel mill equipment is helping in a new expansion program designed to increase steel production in mid-America

ALONG the banks of the mighty Mississippi, near the geographical center of mid-America, new steel-making facilities are being planned. Granite City Steel Company is planning another major expansion program which will raise their ingot production 30% by early 1958.

Just two years ago, Granite City Steel completed an $89,000,000 expansion. It was the culmination of a 7-year program, in which Allis-Chalmers supplied all major electrical requirements, bringing this midwestern plant up to maximum efficiency.

In this new modernization, Allis-Chalmers steel mill equipment will again play an important role. So far, Granite City has called on Allis-Chalmers for all the necessary electrical equipment needed to revamp their cold-strip mill, and the single-stand temper mill, plus other auxiliary machines.

Allis-Chalmers specializes in mill modernization and expansion. For specific information on drives, control and other electrical equipment for steel mills, contact your A-C representative, or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

Other Allis-Chalmers Products for the Steel Industry

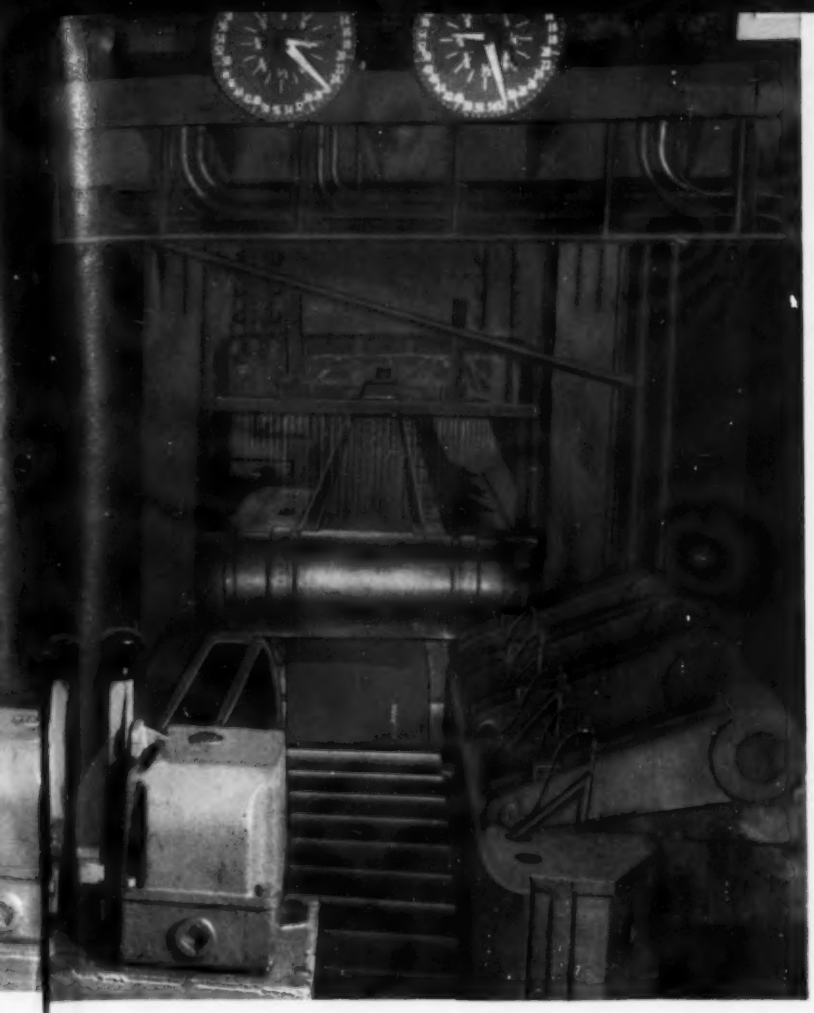
Centrifugal Blowers • Axial Blowers • Arc-Furnace Transformers • Mercury-Arc Rectifiers • Rotary Compressors
Unit Substations • Switchgear • Circuit Breakers • Voltage Regulators • Power Generation Equipment

A-C ALLIS-CHALMERS

ALLIS-CHALMERS

A-5178

Regulex is an Allis-Chalmers trademark.

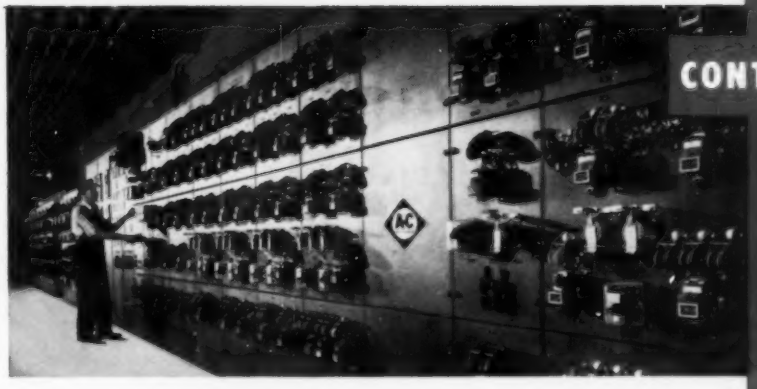


M-g sets supporting cold-strip mill motors. These units are rated at 7750 kw, 514 rpm. Furnished by Allis-Chalmers in 1946, they will be supplemented by new units.

M-G SETS

On the 56-inch temper mill, this 4-machine m-g set supporting the skin pass mill motors will be revamped. Two new 225-kw dc drag generator units will be furnished by Allis-Chalmers for this mill.

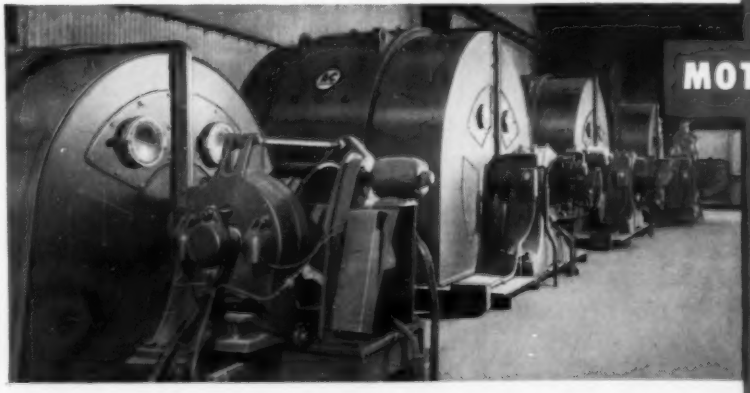
CONTROL



This variable voltage control board is used on the 56-inch tandem cold reduction mill. New control equipment is being furnished by Allis-Chalmers for new mill expansion at this midwestern steel plant.

Regulex control and totally enclosed control board were furnished by Allis-Chalmers in 1948 for the 48-inch temper mill at Granite City Steel Co. Additional control is being furnished for the 56-inch temper mill.

MOTORS

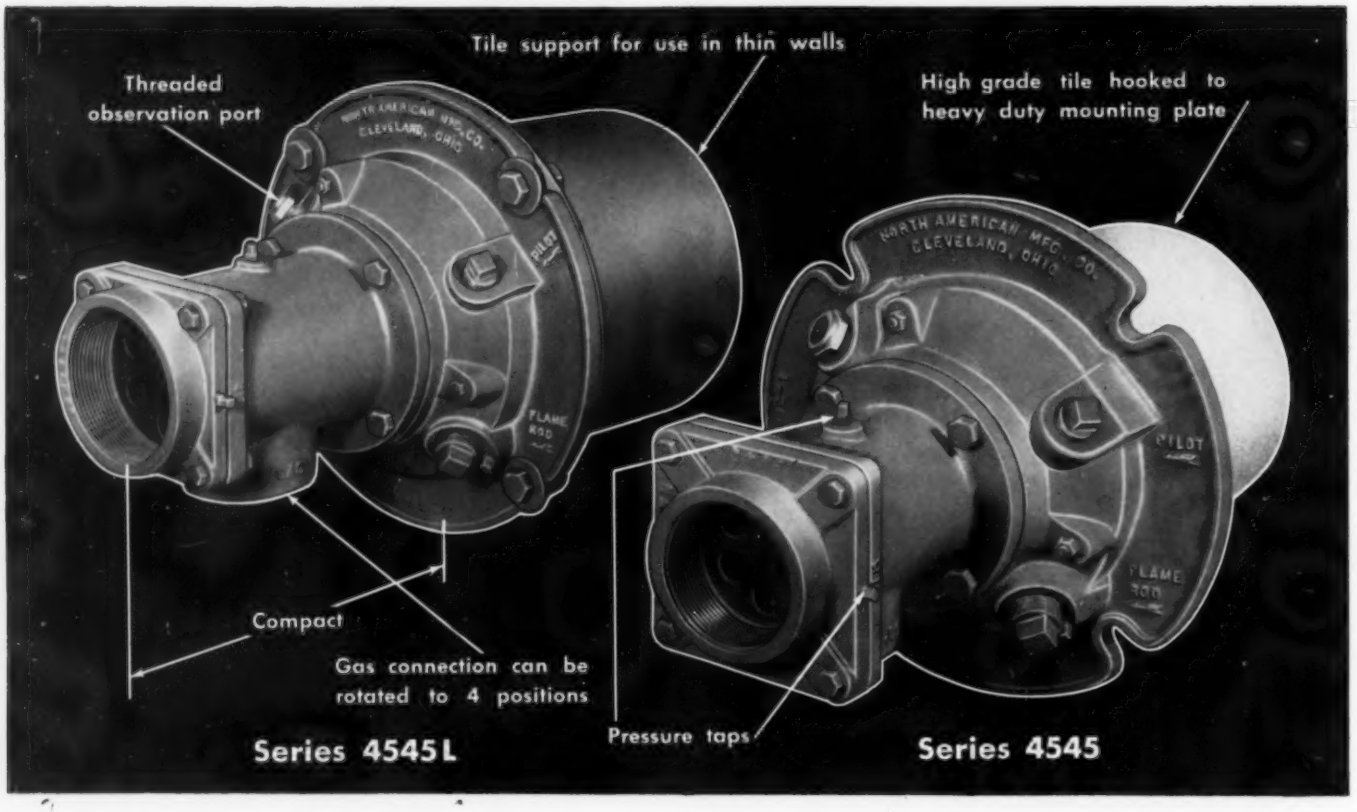


Motor room view at this plant shows Allis-Chalmers units driving delivery reel and main stands. Allis-Chalmers motors furnish drive power throughout the plant. New motors, ranging in size from 25 to 5000 hp, are being installed.

Allis-Chalmers motors shown driving the temper mill include main roll drive, delivery tension, and delivery reel drive. Allis-Chalmers furnished original motors for both temper mills, as well as new motors for increasing capacity.

Penetrating Heat

by North American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Compact
Gas connection can be rotated to 4 positions
Pressure taps
Series 4545L
Series 4545

Nozzle-Mixing Gas Burners

High velocity central jet gives deep penetration
Sealed-in for complete atmosphere control

Provision for flame safety with ignition pilot

5 Sizes — 3″ to 8″ — 1.5 to 12.4 million Btu/hr

3′ to 8½′ flame length with 1 psi air

for additional information consult your local n. a. engineer or write for bulletin 4545

the **NORTH AMERICAN** mfg co

Combustion Engineers

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since 1917

How to get maximum combustion efficiency . . . measure <u>both</u> combustibles and oxygen

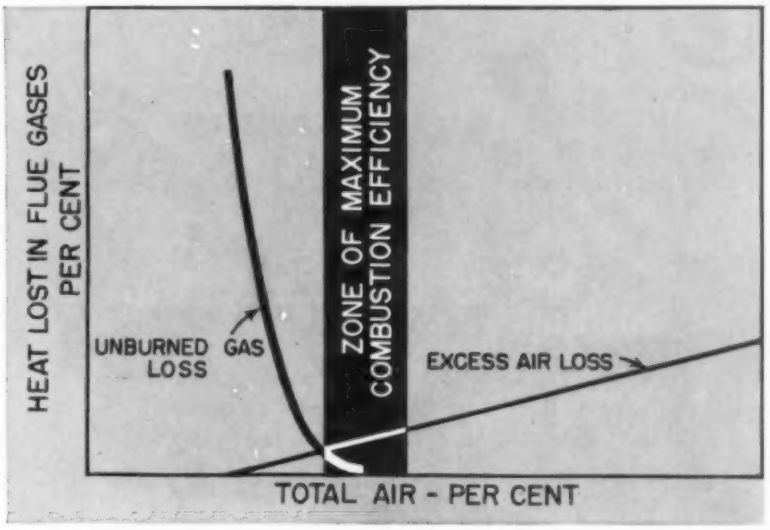
Simultaneous measurement of both oxygen and combustibles is needed to obtain optimum combustion. No instrument that measures only one of these two interdependable factors can give you the full information necessary.

Now, Bailey offers two units, each giving a continuous and simultaneous double check on combustion efficiency: a permanent analyzer-recorder which records both factors on a single chart; and a new light weight, portable unit which indicates both factors.

Both instruments measure: (1) excess air—regardless of the fuel or combinations of fuel being burned. (2) mixing efficiency of your fuel burning equipment by showing per cent combustibles in the flue gas.

Both units are designed to increase efficiency in the furnace operations of the steel industry, on glass tanks, cement and lime kilns, ceramic and refractory kilns, steam boilers and also on direct and indirect-fired furnaces in the metal processing industries.

To prevent your money from becoming waste gas, look into these two efficiency provers. A Bailey engineer will be glad to give you details or write us for product specifications.


HEAT LOST IN FLUE GASES PER CENT
UNBURNED GAS LOSS
ZONE OF MAXIMUM COMBUSTION EFFICIENCY
EXCESS AIR LOSS
TOTAL AIR - PER CENT

Maximum Combustion Efficiency is secured by keeping the sum of Excess Air Loss and Unburned Gas Loss to a minimum. To do so by the direct method simply measure both oxygen and combustibles in flue gas.

For portable use—
HEAT PROVER Analyzer

The famous Cities Service HEAT PROVER analyzer is now Bailey built and sold. Weighing only 25 pounds, it is a self-contained automatic analyzer including a sampling tip and hose plus a thermocouple for temperature measurement.

Instrument dials are dual range for greater accuracy and sensitivity.

For permanent installation
Oxygen-Combustibles Recorder

The Bailey Oxygen-Combustibles Analyzer-Recorder coordinates both records on one chart. These records enable the operator to keep fuel burning equipment performing continuously in the zone of maximum combustion efficiency. Excess air may be reduced to the point where combustibles begin to show.

G 40-1

Instruments and controls for power and process

BAILEY METER COMPANY

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Personnel News...

Walter F. Munford has been appointed an assistant executive vice president of United States Steel Corp., with headquarters at Pittsburgh, Pa., effective December 1. He was formerly president of the American Steel & Wire Division. At the same time **Van H. Leichliter,** vice president in charge of operations of American Steel & Wire was named to succeed Mr. Munford as president of the division. Mr. Munford became an employee of the Wire Division as an open hearth helper in South Works, Worcester, Mass. After steady progress through the ranks at Worcester, he became superintendent of open hearth at the Division's Newburgh Works in 1927. Three years later, he transferred to the National Tube Division at Lorain, Ohio as assistant superintendent of the Steel Works. In 1934, he returned to the Wire Division in Cleveland as assistant superintendent at Cuyahoga Works, becoming superintendent in January, 1937. After a period as assistant to the vice president of the Division in 1939, he was made assistant manager of operations of the Pittsburgh District in December of that year. In 1942 he was named manager of operations of the Worcester district from which post he moved to assistant vice president in charge of operations three years later. In 1950 he became vice president to fill the vacancy created by the elevation of his superior, **Harvey B. Jordan,** to the presidency of the Wire Division and in 1953 he became, in turn, president of the Wire Division.

Mr. Leichliter joined U. S. Steel in the metallurgical laboratory of the Wire Division in 1930. After five years he was moved to the vice president's office in Cleveland as a metallurgist. In 1935, he became district metallurgist in Cleveland, and was made assistant superintendent of Newburgh Works a year later. In 1939 he was named superintendent of the wire mills at Cleveland's Cuyahoga Works. Two years later he was transferred to Worcester's South Works to become superintendent of the wire mills there. In 1944, Mr. Leichliter was made division superintendent and in 1945, became general superintendent at Worcester. In 1950, he was named assistant vice president—operations, with headquarters at the division's general offices in Cleveland. Mr. Leichliter was elevated to vice president—operations on January 1, 1953.

Francis H. Wickline has been appointed assistant chief engineer of National Tube Division, U. S. Steel Corp. He joined U. S. Steel in 1942 in the project engineering department of the Homestead District Works. In 1946 he was transferred to National Tube's construction engineering department at Lorain, Ohio, where he was in charge of electrical engineering for the major expansion both at Lorain Works and National Tube Division's Fairless Works. In 1952 he was transferred to the Pittsburgh office as electrical engineer for the entire National Tube Division.

Robert E. Hagen has been appointed superintendent of United States Steel Corp.'s Saxonburg Plant of Edgar Thomson Works. Mr. Hagen joined U. S. Steel at its Oliver Iron Mining Division, Duluth, Minn., in 1949 as an assistant iron ore concentration engineer. Following various advancements, he became a development engineer, the position he held prior to his new appointment.

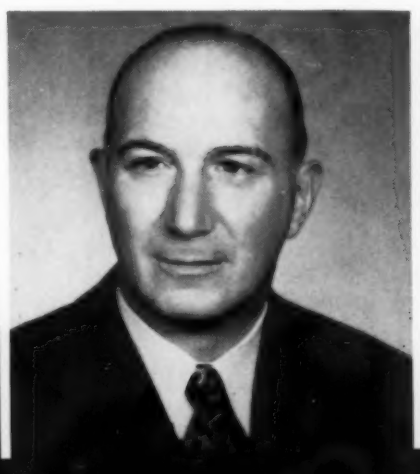
Kenneth G. Hunt was appointed superintendent of construction and shops at the Midland Works of Crucible Steel Co. of America. Mr. Hunt was previously employed as superintendent of mechanical and electrical maintenance and construction at Ford Motor Co.'s Rouge Steel Plant, Dearborn, Mich. Prior to his employment with Ford, he was an erection manager for the John Mohr Co. and was in charge of construction of the Midland Plant's No. 1 blast furnace, which was completed in 1952.

Mark T. Anthony has been appointed assistant to the vice president and general manager of Kaiser Steel Corp. He succeeds **A. F. (Frank) Scarr,** recently named assistant general manager of Kaiser Center, Inc., Oakland, Calif. Mr. Anthony joined Kaiser Steel in 1946 as assistant to the market consultant and later served as assistant director of the company's general planning department. In 1955, he was named assistant manager of Kaiser Steel's Central District sales office in Oakland.

A. H. Wardwell has been appointed assistant to the vice president, American Steel and Wire Division, U.

WALTER F. MUNFORD

VAN H. LEICHLITER



FRANCIS H. WICKLINE

ROBERT E. HAGEN

A. H. WARDWELL

JACOB W. COX

KENNETH F. WAGGENER

STEWART H. KILMER

S. Steel Corp., and **Jacob W. Cox** succeeds him as the director of raw materials. Mr. Wardwell started as a pyrometer man in the blast furnaces of National Tube Division at McKeesport, Pa., in 1917, being named superintendent of blast furnaces at that plant in 1922. From 1929 to 1935 he was blast furnace and raw material engineer in that division's general offices in Pittsburgh before transferring back to National Works as assistant general superintendent. In 1936, Mr. Wardwell was transferred to Carnegie-Illinois Steel as assistant to general superintendent at South Works, Chicago. He was named director of industrial relations of Carnegie-Illinois, Pittsburgh district, in 1942; and in 1947 supervised the labor relations of the entire subsidiary. Mr. Wardwell came to the American Steel & Wire Division in December of 1947 to take over the newly-created post of director of raw materials—the job he has held until his current appointment. Mr. Cox joined American Steel & Wire as an observer at the Donora, Pa., Steel Works in 1936. For the next three years he held positions in the industrial relations section of the plant before turning to front line management as a turn foreman in the blast furnaces at Donora. In 1946 he was promoted to general foreman at the Central Furnaces & Docks plant in Cleveland. He served in that capacity for two years, and in 1948 was boosted to assistant to the works superintendent at the Coke and Coal Chemical Works of the Division, also in Cleveland. In 1949, Mr. Cox was transferred to the Donora blast furnaces as the division superintendent, and held that job until 1954 when he was named assistant to the general superintendent at the Pennsylvania plant—the post he held prior to his present advancement.

Kenneth F. Waggener has been appointed assistant superintendent of the Bessemer Converter mill of the Youngstown District of Republic Steel Corp. Mr. Waggener, who joined the company in 1937, was general charging foreman of the open hearth furnaces for the past three years.

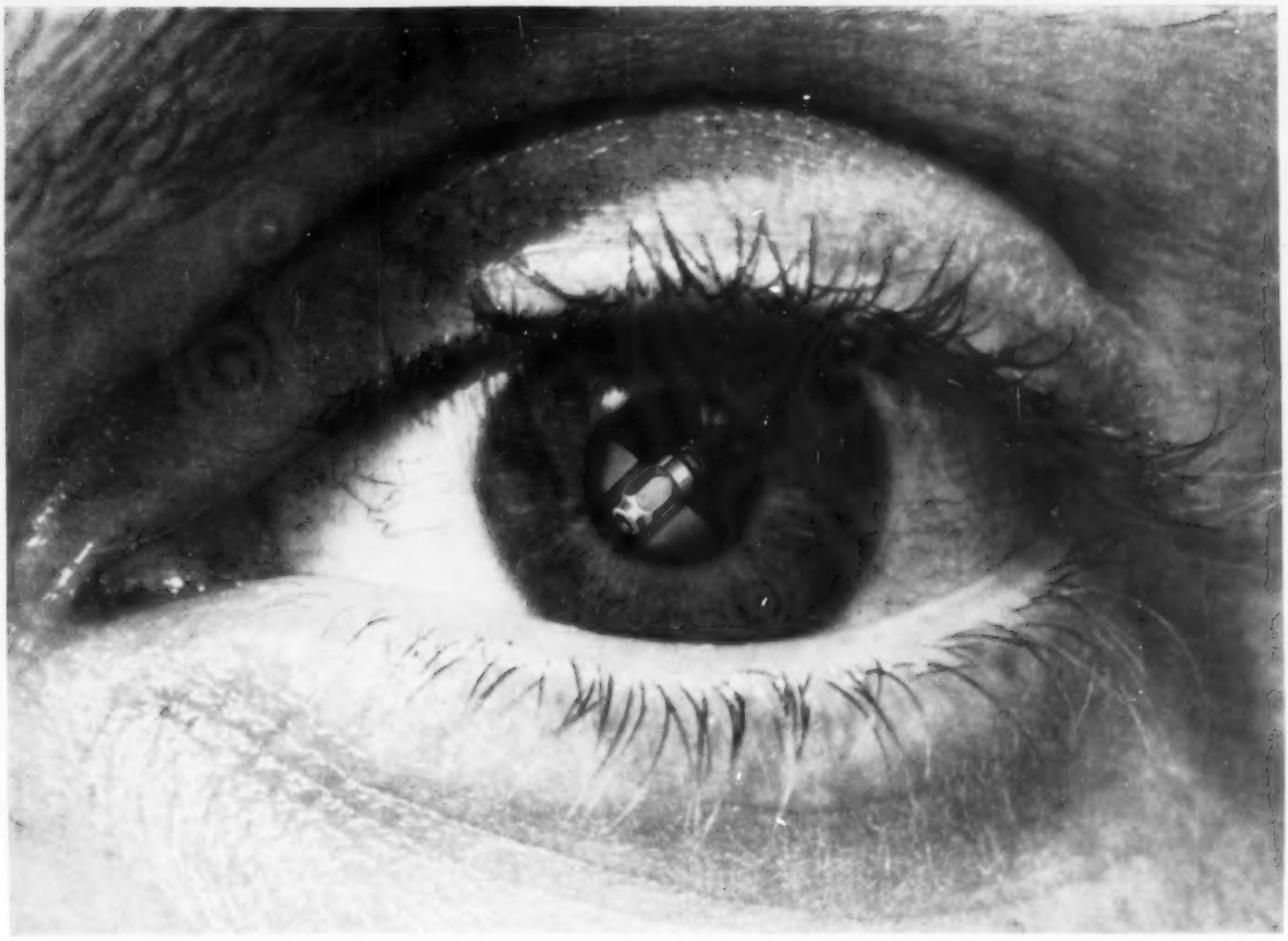
Stewart H. Kilmer has been appointed works manager of the Ambridge, Pa., plant, Spang-Chalfant Division of the National Supply Co. He succeeds **Ernest G. Unrath,** recently named vice president—manufacturing. At the same time, **Myron J. Demeter** was promoted to assistant works manager, **George H. Shiveley** to general superintendent, and **Herbert T. Buchholz** to plant controller.

Harry E. Boedecker has joined the organization of Ramseyer & Miller, Inc., New York, N. Y., Consulting Engineers to the iron and steel industry. Mr. Boedecker has been assigned to the International Cooperation Administration (ICA) of the United States Government and will be stationed in New Delhi, India, where he will visit steel plants in India on a country

H. E. BOEDECKER

wide basis as assigned from time to time by the Government through the Technical Cooperation Mission to India (TCM/I). Mr. Boedecker was previously connected with the Northeastern Steel Corp., Rotary Electric Steel Co., Youngstown Sheet & Tube Co., Crucible Steel Co. of America, Brazilian National Steel Co. (Brazil), and Atlas Steels Ltd. (Canada), in electrical and mechanical supervisory capacities.

Louis F. Coffin, assistant general manager of Bethlehem Steel Co.'s Sparrows Point plant has retired. Mr. Coffin joined Bethlehem as mechanical engineer in 1916. In 1920 he was made general master mechanic and in 1932 he was named superintendent of the me-



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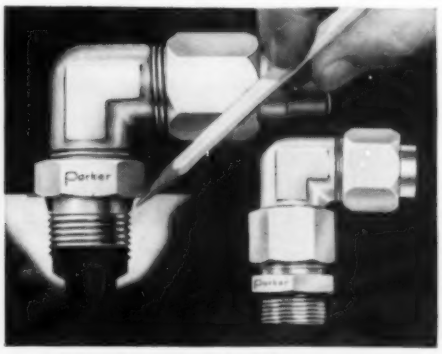

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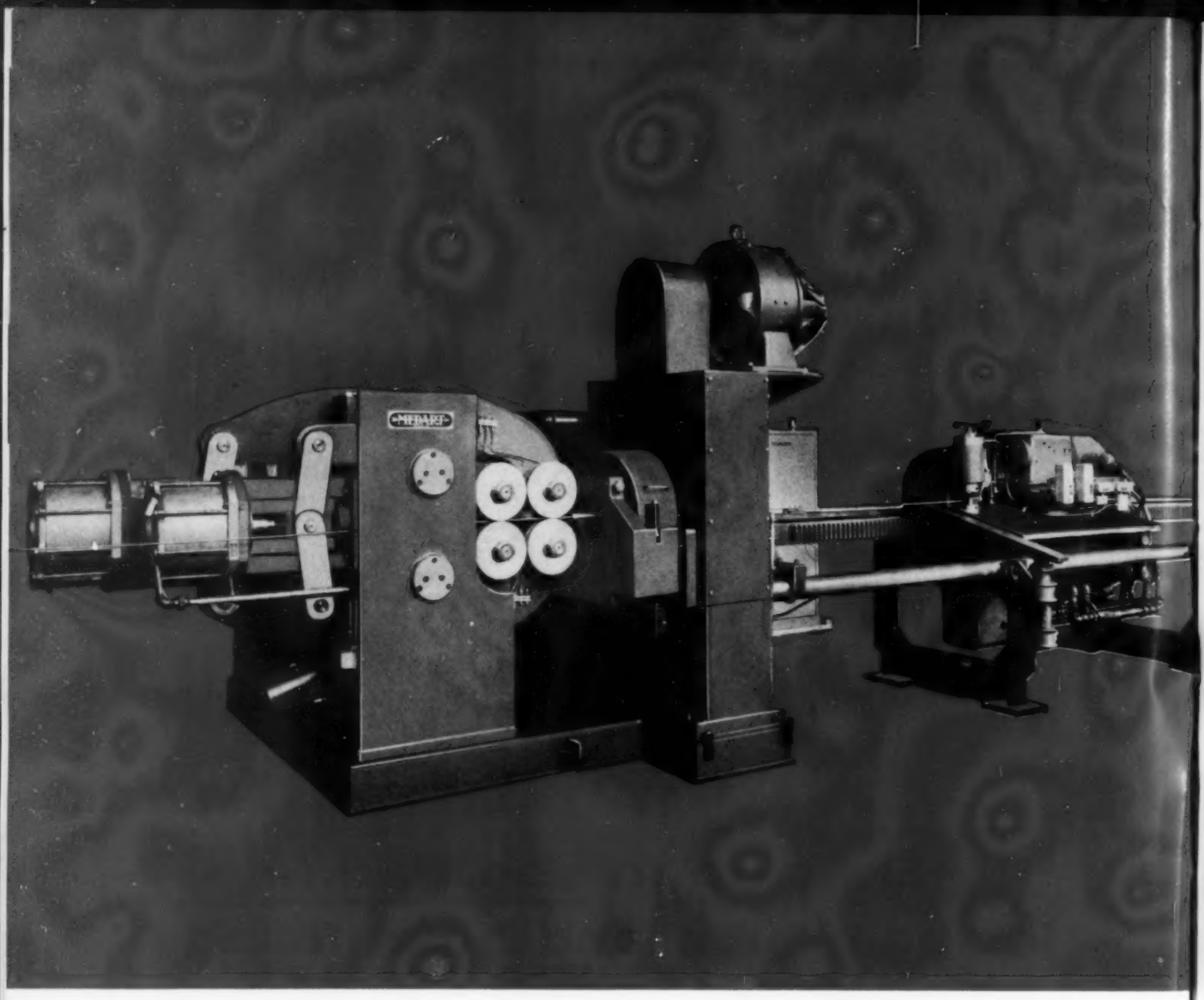

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Foundry & Machine

chanical department at Sparrows Point. He has served as assistant general manager since 1952. Mr. Coffin was president of the AISE in 1938, and was an honorary director of the Association for a number of years.

Edward C. Peterson has been elected vice-president, Rolling Mill Equipment Division at the Birdsboro Steel Foundry & Machine Co. Mr. Peterson was formerly assistant to the vice-president—engineering, a position he had held since 1954. He succeeds **Edward T. Peterson,** who is continuing with the company as senior engineer.

Henry J. Forsyth was named director of steel conservation and quality control for the Youngstown District of Republic Steel Corp. Mr. Forsyth, formerly assistant director of steel conservation and quality control at Republic's general offices in Cleveland, joined the company in 1934 as an inspector in Buffalo, N. Y. He later was made superintendent of steel conservation in Buffalo, serving in that capacity until taking over his previous duties in Cleveland in 1948. Prior to joining Republic, he was a control chemist with the Strong Steel Foundry in Buffalo.

Edward E. Helm was elected president of Reliance Electric & Engineering Co. He succeeds **James W. Corey** who was made chairman of the board of directors. Mr. Helm, who has served as vice-president and general manager of the company since last January, joined Reliance in 1924. Filling successively both district and home sales engineering and managerial assignments, he was sales vice-president from 1946 to 1956. He was elected to the board of directors in 1947. Mr. Corey's association with the company has been continuous since 1913. He has been a member of the board of directors since 1935 and was elected president of the company in 1944.

W. Earle Black has been promoted to the position of resident engineer at the Pittsburgh Works of Jones & Laughlin Steel Corp. He formerly was project development engineer at the Pittsburgh Works. Mr. Black succeeds **D. H. Miller,** who earlier was named planning and development engineer in J&L's general office. Mr. Black joined J&L as a supervising engineer at the Pittsburgh Works in 1926. He was named project development engineer in June, 1956.

Frederick H. Bremmer was named superintendent, cutting department, Ambridge Plant, Spang-Chalfant Division of the National Supply Co. Mr. Bremmer started at the plant as a metallurgist in 1929 and has been chief combustion engineer since 1945. Other appointments are: **Joseph A. Frederick, Jr.,** chief combustion engineer. **Harry W. Griffith,** superintendent, threading department. **O. H. Meineke,** consultant, mechanical and electrical departments. **William H. Hunter,** superintendent, mechanical department. **Enos Lowerree,** general foreman, hot operations, mechanical department and **Wilmer G. Seyboth,** superintendent, electrical department.

Francis J. Myers and **Walter G. Crusberg** have been appointed district managers of Republic Steel Corp. iron ore mines in the Adirondacks at Mineville and Lyon Mountain, N. Y. **William J. Linney,** who died recently, had been manager of both operations. Mr. Myers was assistant district manager at Mineville and Mr. Crusberg was assistant district manager at Lyon Mountain.

Richard B. Lord has been appointed director, product development division—commercial department of United States Steel Corp. He succeeds **L. S. Brock,** recently appointed assistant manager, structural and plate steel sales division. Upon completion of the Carnegie-Illinois sales training course in 1946, Mr. Lord was transferred to the Chicago district sales office as a sales correspondent. He served in several sales capacities in the Chicago office before being named assistant to the manager, sheet and strip steel sales division in 1953, the position he held until his present appointment.

Walter L. Murphy, formerly engineer—combustion, has recently been appointed to assistant to the general manager of the South San Francisco plant of Bethlehem Pacific Coast Steel Corp.

William Page was named district sales engineer in the Cleveland office of Thermal Research and Engi-

EDWARD C. PETERSON

HENRY J. FORSYTH

EDWARD E. HELM

JAMES W. COREY

neering Corp. At the same time **Harold Horn** was named district sales engineer in charge of the New York office.

Fred S. Van Valkenburg has been elected chairman of the board and **A. Dale Mitchell** made president of the Waterbury Farrel Foundry & Machine Co. Mr. Van Valkenburg who has been a vice president and director of the company for several years replaces **R. L. Wilcox** who retired from the position of board chairman several months ago. Mr. Mitchell, formerly treasurer of the company, takes over the position of president which was vacated by the death of **Joseph Schaeffer** in September of this year.

William L. Van Winkle has been appointed steel mill roll sales representative in the Pittsburgh area by Birdsboro Steel Foundry & Machine Co. Mr. Van Winkle was formerly with Midvale-Heppenstall Co., where he was metallurgist, supervisor of quality control and subsequently responsible for specifications and layout for roll manufacture. He has been engaged in roll sales for the past nine years.

Louis G. Helmick has been named to the newly created post of vice president and general manager of Joy Manufacturing Co.'s Industrial Division. In his new position, Mr. Helmick will be responsible for research, engineering, manufacturing, and sales of Industrial Division products.

Eugene M. Smith was named to the new position of research administrator of Lukens Steel Co. In this capacity he will be responsible primarily for the development of new metallurgical and chemical products and processes. He joined the company's Research Division in 1954, following experience with Youngstown Sheet and Tube Co., Battelle Memorial Institute and Aluminum Co. of America.

Albert S. Burgoyne has been appointed to the newly-created office of vice president in charge of manufacturing of the E. W. Bliss Co. Mr. Burgoyne will be responsible for coordinating and directing the activities of the company's twelve manufacturing plants throughout the United States. He was formerly with the Gage Division of Pratt and Whitney Co., Inc.

Walter J. Kalmeyer has been advanced to vice president and **Clay C. Hopper** has been appointed assistant general manager of Standard Steel Corp., Los Angeles, Calif. Also named were **Norman Pitt** as chief engineer and **Edward J. Meier** as public relations director. Mr. Kalmeyer, who has been production manager, will continue to serve in that capacity, in addition to supervising all phases of manufacturing for the company. He was associated with Blaw-Knox Co. for 23 years, becoming manager of its Pittsburgh plant in 1951.

Arthur A. Archer has been appointed vice president —engineering for Mosebach Electric & Supply Co. Mr. Archer has done power plant work for the United Gas Improvement Co. of Philadelphia, Pa. and coke plant work for the United States Steel Corp. at Fairfield, Ala., following which, he joined Hillman Coal & Coke Co. in Pittsburgh as assistant chief engineer of construction. In 1927, he joined Pittsburgh Coal Co. as assistant engineer in design and construction and later became chief engineer of a subsidiary of the parent company.

Jordan D. Raileanu has been named assistant plant manager of the Worcester, Mass., plant of Solar Steel Corp.

L. W. Long and **J. H. Burrus, Jr.** have been appointed assistant general managers of Allis-Chalmers Manufacturing Co.'s Power Equipment Division. In addition, **A. I. Thorsen** has been appointed general manager of the company's Terre Haute, Ind. Works succeeding Mr. Long.

John F. Welch has been appointed general manager of the General Electric Co.'s Small Integral Motor Department at Fort Wayne, Ind.

William C. Greenleaf has been named manager of Metals Development for U. S. Industrial Chemicals Co., Division of National Distillers Products Corp. In his new position, Mr. Greenleaf will be responsible for market development and sales of zirconium and titani-

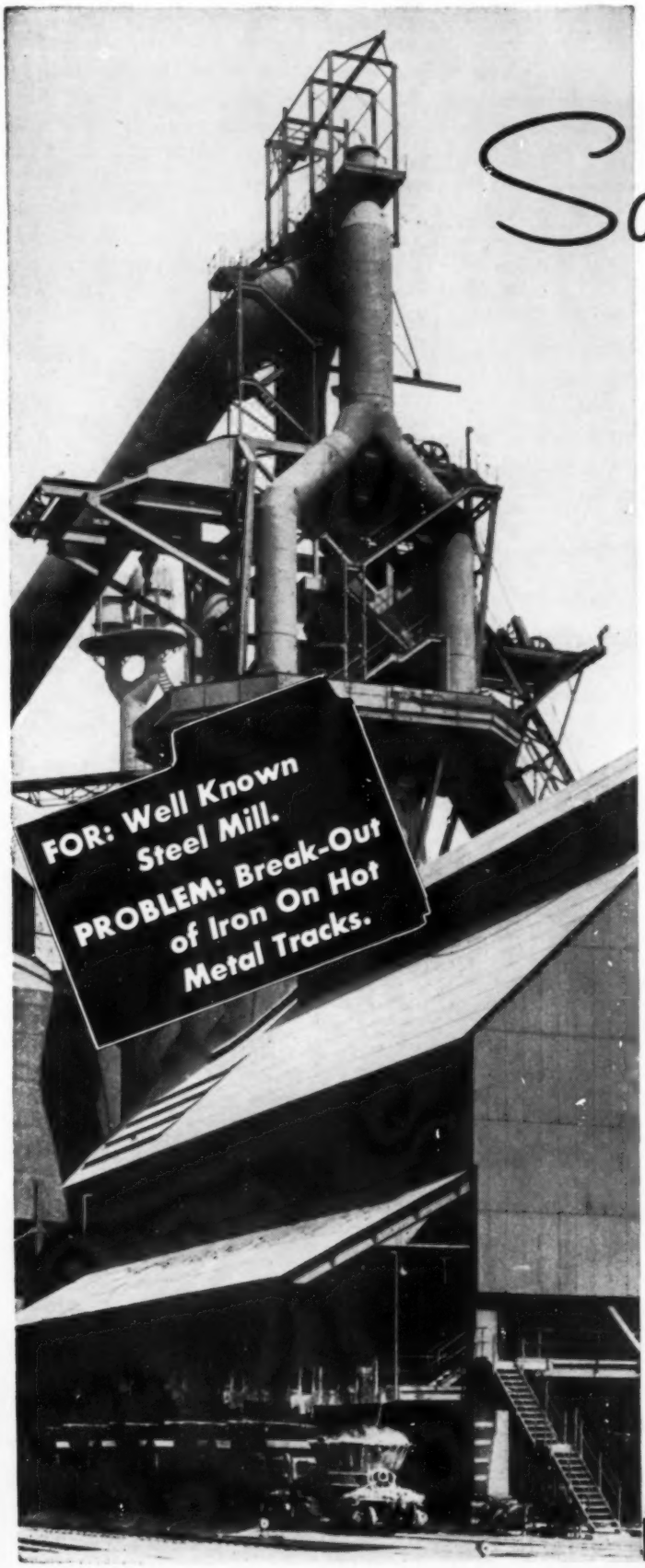
F. S. VAN VALKENBURG

A. D. MITCHELL

W. L. VAN WINKLE

L. G. HELMICK

CHICAGO CONCRETE ON THE JOB IN HOURS



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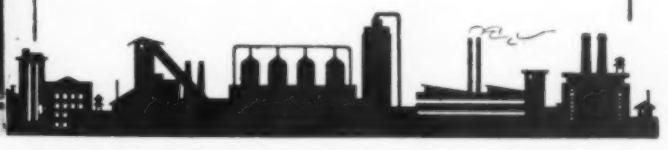

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um sponge, to be produced from U. S. I.'s two new plants now being built in Ashtabula, Ohio. Mr. Greenleaf, has been employed for the past ten years by Allegheny-Ludlum Steel Co. Previous to that he held metallurgical posts with United States Steel Corp., Armco Steel Corp., Republic Steel Corp. and Youngstown Sheet and Tube Co.

Howard M. Perry has been appointed manager-sales for General Electric Co.'s Small Steam Turbine Department. He succeeds **Charles B. Seelig** who was recently named manager-marketing.

Glen H. Lufcy has been appointed superintendent at the Ottawa, Ill., works of Laclede-Christy Co. Division, H. K. Porter Co., Inc. Mr. Lufcy was in charge of quality control at Ottawa from 1954 until his recent promotion. Previously he was with Owen-Illinois Glass Co.'s general research and new development division and before this was project engineer for two major refractories companies.

Jonathan W. Freeman has resigned as president but remains chairman of the board of Pittsburgh Tube Co., and **William K. Hahn, Jr.**, until now vice president and treasurer, has been elected president. At the same time, **H. M. Feely, Jr.** has been elected vice president—operations. He began his career as an engineer in the company plant in 1934, becoming chief engineer, and in 1950 plant manager.

Radcliffe P. Cheesman has been named manager-product service for General Electric Co.'s Small Steam Turbine Department.

N. H. Hobbie has been appointed district manager of Air Reduction Sales Co.'s Charlotte, N. C., district sales office. Mr. Hobbie, formerly assistant sales manager at Charlotte, succeeds **J. B. Davenport** who died recently. **J. S. Stevens,** zone manager in Airco's Railroad Department, has been appointed to succeed Mr. Hobbie as assistant sales manager.

Dr. Terence E. Dancy has been appointed development engineer in the Process Development Section, Technical Services Division, Jones & Laughlin Steel Corp. At the same time **Richard L. Guernsey** was appointed metallurgical contact engineer, Tubular Products. Dr. Dancy, a native of England, formerly served as commercial development officer with the British Iron and Steel Research Association. From 1945 to 1952, Dr. Dancy was in the Iron Making Division of the British Iron and Steel Research Association. From 1953 to 1954, he was attached to the British Commonwealth Scientific Office in Washington, D. C., as Metallurgical Liaison Officer. Mr. Guernsey comes to J&L from Colorado Fuel and Iron Corp. where he was a sales engineer. Previous to that he served with Youngstown Sheet and Tube Co. for 12 years, lastly as a field engineer.

Marshall Dreitzler has been named as a sales representative in the Chicago area by Lewis-Shepard Products, Inc. Mr. Dreitzler has been associated with the material handling industry for the past 14 years.

G. E. Conn, manager of the York district of Allis-Chalmers Industries Group since 1947, has been appointed manager of the Buffalo district succeeding **Henry E. Weiss.** Mr. Weiss, who has been with Allis-Chalmers for 45 years and manager at Buffalo since 1936, has been named a special representative there. Mr. Conn was a representative in the Philadelphia district before being named manager at York. **MacGregor G. Jones,** a sales representative at York since 1947, succeeds Mr. Conn as manager there.

John W. Hammarberg has been appointed a district representative in the Detroit sales office for Heppenstall Co. Mr. Hammarberg was employed in the production department of the Heppenstall-Eddystone Corp., from 1942 to 1944. Subsequently he became manager of the production control department of the Baker Refrigeration Corp. In 1951 he joined the Liggett Spring and Axle Co., and served as sales manager at the time of his appointment by Heppenstall.

Obituaries

Howard L. Dawson, Assistant Vice President, Industrial Engineering at United States Steel Corp., died September 22, 1956.

Walter A. Rankin, 67, a manufacturer's representative, died October 7. He operated the Walter A. Rankin Co. in Drexel Hill, Pa.

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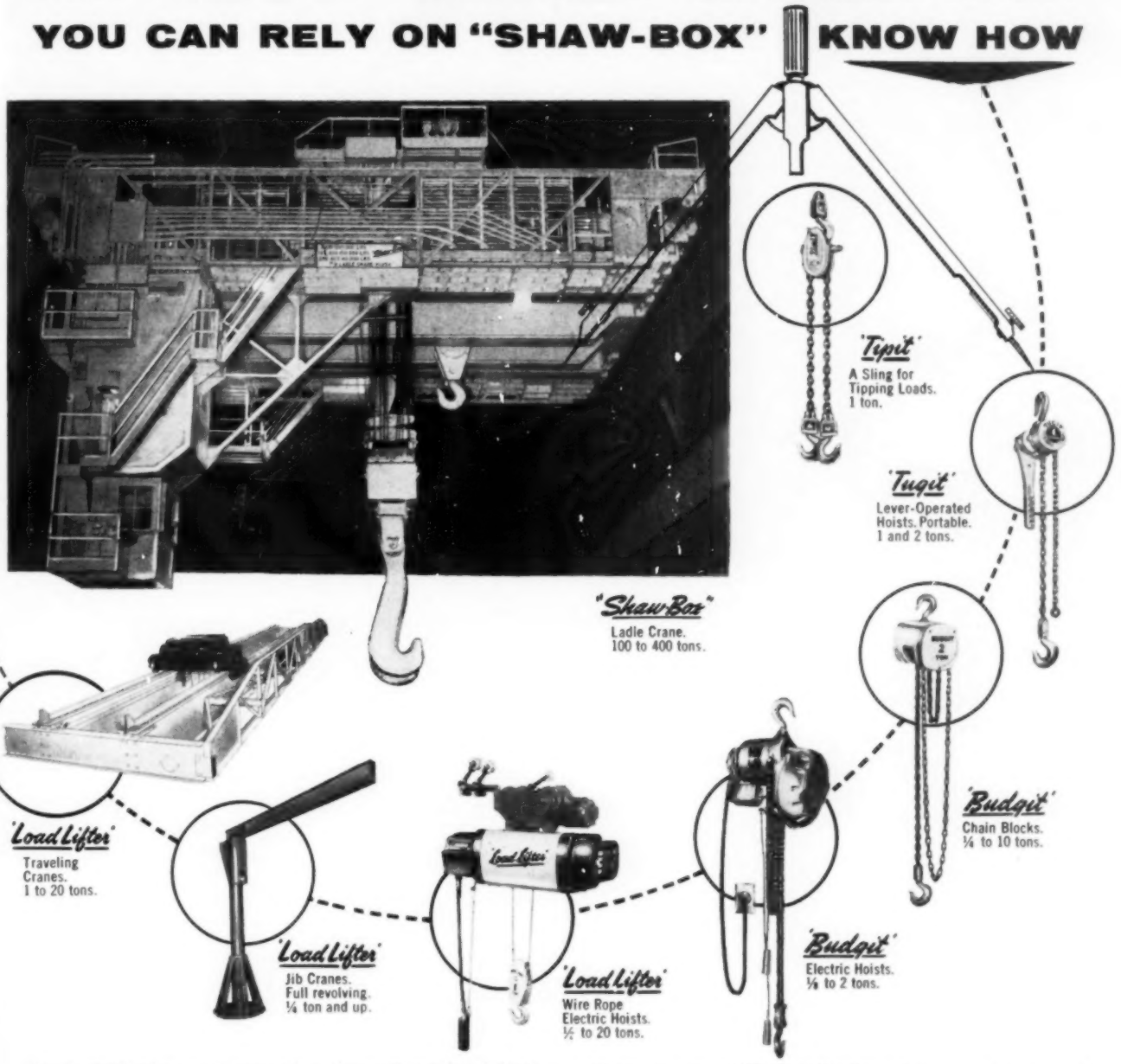
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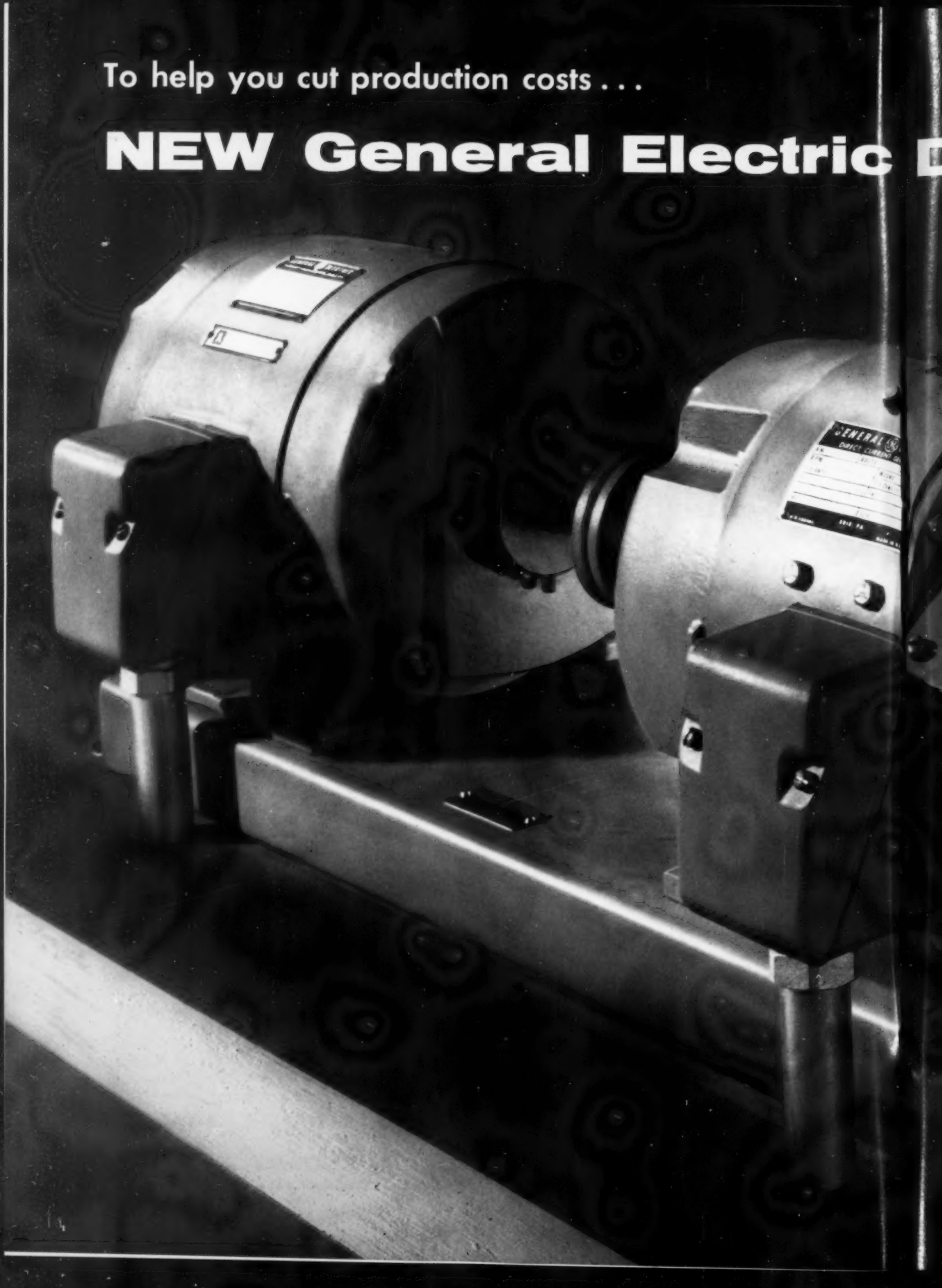

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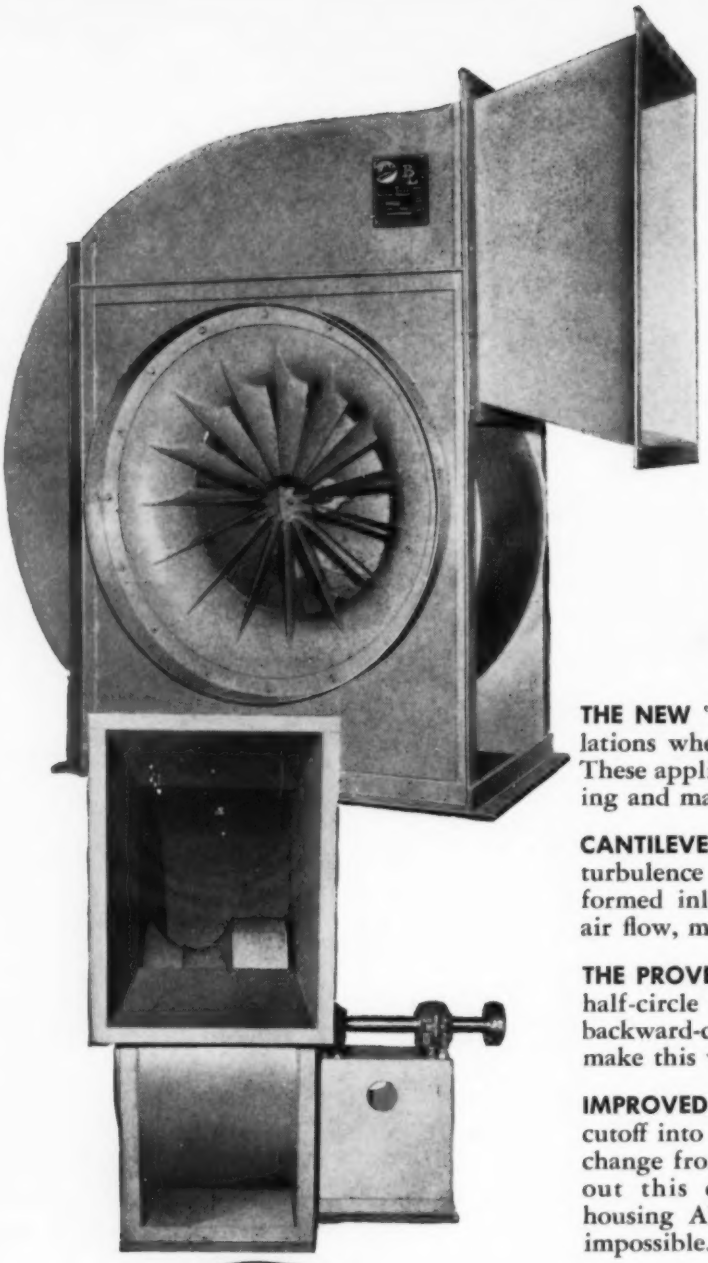

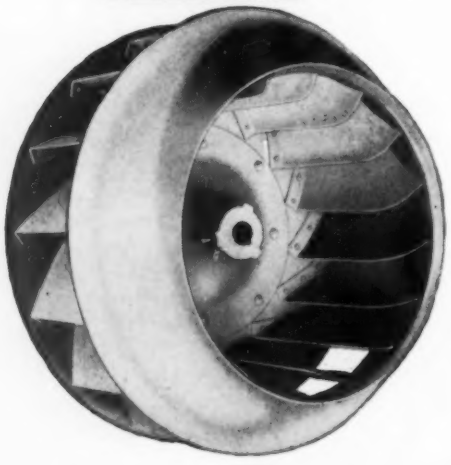

NEW!

BUFFALO "BLH"
FOR CLASS II THRU IV
VENTILATING-INDUSTRIAL & MECHANICAL DRAFT SERVICE

THE NEW "Buffalo" Type "BLH" FAN is engineered for installations where total pressure requirements of 3¾" and up exist. These applications include mechanical draft, conduit air conditioning and many industrial applications.

CANTILEVERED INLET VANES eliminate center ring, reducing turbulence and improving air flow through the inlet. The die-formed inlet vanes and inlet bell further contribute to smooth air flow, minimizing effects of unfavorable inlet conditions.

THE PROVEN BL WHEEL has a deep drawn flange to form a true half-circle with the inlet cone. Highly efficient non-overloading backward-curved blades, solid back plate and extra heavy hub make this wheel ideally suited to this service.

IMPROVED FAN OUTLET — reduces outlet air turbulence from fan cutoff into duct by making more even, gradual change from velocity to static pressure. Without this complete streamlining of inlet, housing AND outlet, such high efficiency is impossible.

Smooth Divergent Flow

86% MECHANICAL EFFICIENCY — made possible by a combination of inlet, wheel and housing design. The smoothest "air-ride" in fan history.

"Buffalo" "Q" FACTOR* CONSTRUCTION gives you many years of trouble-free service. Housing is all-welded construction. Wheel and blades are riveted and welded for maximum strength, the basic design having been thoroughly tested in the Vacuum Pit, a "Buffalo" exclusive.

AVAILABLE in wheel diameters from 18¼" to 80¾", the new "Buffalo" "BLH" merits your consideration. Write for details on your company letterhead — today.

**The "Q" Factor — the built-in Quality which provides trouble-free satisfaction and long life.*

BUFFALO FORGE COMPANY

BUFFALO, NEW YORK

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

"Buffalo"

VENTILATING AIR CLEANING AIR TEMPERING INDUCED DRAFT EXHAUSTING FORCED DRAFT COOLING HEATING PRESSURE BLOWING

Publication Service...

NOVEMBER, 1956

You Can Obtain . . .

. . . any of the bulletins reviewed in the Publication Service of the IRON AND STEEL ENGINEER without obligation or cost. Simply circle the desired item numbers on one of the prepaid postal cards and mail. The requests will be forwarded to the manufacturers involved who will send the bulletins to you.

Note: Post cards expire three months after publication date.

(1) Strip Thickness Control Systems

AccuRay strip thickness control systems to improve uniformity, save material, and increase production in the metalworking industry are described and illustrated in a new 12-page booklet published by Industrial Nucleonics Corp. Among the subjects covered in this bulletin are automatic strip thickness control of ferrous and non-ferrous tandem and reversing cold mills, measurement of zinc and tin coating, and systems for classifying and assorting lines. (Bulletin No. B1556)

(2) Casting Design

A 64 page manual just published by the Meehanite Metal Corp. provides usable working data in a simple, interesting manner. It treats the form of design, the method of making the pattern, molding procedure, the characteristics and behavior of the metal in the mold and other elements involved in the production of sound, dependable engineering castings. (Bulletin 44)

(3) Circuit Breakers

I-T-E Circuit Breaker Co., has released a bulletin on their complete line of Cordon current-limiting circuit breakers. This bulletin shows how protective elements in the circuit breaker are coordinated to provide complete protection on overloads, short circuits, and faults of high magnitude. Individual design features of this compact protective device are highlighted and described through illustrations. (Bulletin 5042)

(4) Electronics Catalog

Allied Radio Corp., has published a general electronics catalog placing special emphasis on equipment for industrial maintenance, research and production requirements. There are detailed listings of standard and special-purpose electronic tubes, test instruments, voltage stabilizers, transformers, resistors, capacitors, printed circuit components, the new transistors, rheostats, relays, switches, rectifiers, fuses, tools, wire, cable, photo-electric components, nuclear instruments, sound-powered telephones, counters, program clocks, batteries, sockets, generators, power supplies, and a wide variety of other electronic equipment and components.

(5) Explosion-Proof Motors

Described in a new bulletin released by Allis-Chalmers Manufacturing Co., is the latest design features of their explosion-proof motors in NEMA rerated ratings of ½ to 30 hp (Type GZZ) and in non-rated ratings of ½ to 100 hp (Type APZZ). In addition to cutaway views of the motor, the bulletin includes tables of ratings and dimensions as well as a horsepower frame chart. (Bulletin 51B7286G)

(6) Hardening Rail Ends

A high-speed, low-cost automatic method of selectively hardening the wearing surface at the end of each rail is described in a bulletin published by Selas Corp. of America. The booklet, entitled, "Hardening Rail Ends" contains illustrations showing the production equipment as well as the metallurgical characteristics of the treated rails. (Bulletin S-1051)

(7) Air Pollution

A brochure entitled, "Tools and Techniques in Air Pollution Control" is available from Hemeon Associates. The brochure gives a description of scientific methods available for the study of various aspects of air pollution. It includes discussion of pilot scale research, testing and design; tall stack dispersion analyses by model wind tunnel and micrometeorological studies; new-plant surveys; dust collector and fly ash arrestor acceptance testing; particle size measurements in dust collector and air cleaner applications; stack emission surveys; stack gas tracer studies; and community surveys for ordinance and zoning development.

(8) Static Switching Systems

A new bulletin on static switching systems is now available from the General Electric Co., the publication describes the operation of a static switching system and lists its advantages as reduced downtime, easy maintenance, greater reliability, greater flexibility, reduced inspection and replacement, and minimized atmospheric problems. In discussing areas for applying static switching systems, the bulletin cites operations in which dependability, a high degree of automation, frequent operation, or maintenance under severe atmospheric conditions is an important factor and recommends the consideration of this contactless control for such application. (GEA-6364)

(9) Electrojet Units

Askania Regulator Co., has published a bulletin explaining their "Electrojet," an electro-hydraulic unit which creates powerful hydraulic output thrust or torque from low level electrical input signals, from various sensing elements. Typical applications in position servomechanisms, floating control systems and other functions are described. (Bulletin 38.1)

(10) Magnets

A new bulletin on the company's line of rectangular and rail handling magnets is announced by the Ohio Electric Mfg. Co. The bulletin describes the complete line of magnets ranging in size from 19 x 32 in. up to 28 x 74 in., gives data on materials of construction, head-

room required, dimensions, etc. (Bulletin 150-A)

(11) Water Filters

R. P. Adams Co., Inc., has published a bulletin entitled, "AWF Filters for Complete Automation." This ten page bulletin contains cut-away sections and drawings to show the operation of the filter. Dimension charts and flow curves are given for all three sizes of AWF Filters and for Poro-Stone, Poro-Screen and Poro-Edge elements. Some typical installation photographs are also included along with cut-away section of the Adams IWF, WFF and WFS Filters.

(12) Pneumatic Controllers

A 56-page bulletin describing the new Series 500W pneumatic controller has just been announced by the Bristol Co. This new bulletin is illustrated by more than 75 photos and drawings, describing the new high sensitivity, wide control-band controllers for temperature, pressure, flow, vacuum, etc. Features of the new controllers mentioned include: control band width ½ per cent to 400 per cent, high sensitivity without loss of stability, precision linkage allowing reassembly and recalibration with only one adjustment, and reset action stops. Sections describing control principles, and illustrating the various control modes available are included. The modes of control offered are narrow-band (on-off), proportional, reset, derivative, and reset plus derivative. Reset rates from 0.1 to 10, or 1 to 300, and derivative times of 0.2 to 20 minutes are offered. (Bulletin A130)

(13) Circuit Breakers

A new, completely revised bulletin covering general purpose circuit breakers of the hydraulic-magnetic type has been released by the Heinemann Electric Co. This bulletin describes in detail the hydraulic-magnetic principle, design, operation, and application of this circuit breaker. Schematic diagrams, time-delay curves, and other helpful engineering information are included. Data on basic design considerations, voltage drop curves, interrupting capacities and similar information is also covered in tabular or graphic form. Superimposed wiring diagrams on dimensional drawings give a graphic representation of all special circuit forms. Wiring is shown in color for clarity. (Bulletin No. 3411)

(14) Trunk Attachments

A new four page folder illustrating and describing its cascade load clamp, side shift and rotating attachments for its line of powered industrial trucks has just been released by the Elwell-Parker Electric Co. The booklet covers such equipment as the standard load clamp, the side shift load clamp, the rotating load clamp, the standard clamp with pallet forks, and rotating forks. Seven different load arms are likewise illustrated, together with accompanying text. The folder contains nearly three pages of tables containing detailed specifications of the various attachments, and the types prescribed for various models.

(15) Stokers

A new catalog that describes the operation and advantages of the modified travelling grate type stoker has been published by the Johnston & Jennings Co. The bulletin lists a typical heat balance table and also contains a useful tabulation showing the dimensions of standard stokers that will meet a wide variety of effective grate area requirements. (Bulletin No. 562)

(16) Blast Descaling Process

"Steel Mill Cleaning News" is the title of a new brochure published by Wheelabrator Corp. Dealing with the mechanical blast descaling process the bulletin covers descaling of hot rolled steel sheet and strip, slabs and billets, and plate. It also deals with the conditioning of ingot molds, the dressing of mill rolls, and the cleaning of structurals prior to the application of surface coatings. This illustrated publication contains almost a dozen case histories. They are taken both from mills and from users' plants.

(17) Bus-Way System

A new booklet describing a lightweight, heavy duty trolley bus-way system has been published by Electric Service Works, Delta-Star Electric Division, H. K. Porter Co., Inc. The bulletin contains illustrations of the major components and describes the advantages of the system.

(18) Trucks — Racks

A new 20-page catalog describing the full line of trucks and storage racks is now available from Lewis-Shepard Products, Inc. The catalog contains complete specifications on both the trucks and storage racks and is illustrated throughout with drawings and photos. In addition, the catalog points out many specific commercial and industrial applications for this material handling equipment. (Catalog 29-1)

(19) Induction Heating Equipment

Available from Magnethermic Corp., is an eight-page bulletin on induction heating equipment. The bulletin contains engineering data and illustrations on both low frequency and high frequency equipment. Charts on depth of hardness, low frequency range, high frequency range, and frequency selection chart for steel bar stock heated above curie are also included.

(20) Protective Coatings

"Stop Costly Metal Destruction" is the title of a new four-page illustrated catalog just published by the Markal Co. Complete information is included on the company's line of heat-proof protective coatings, designed to protect metals from scaling and corrosion at temperatures as high as 2100 F; for carburization and decarburization control during heat treating; protection against acids, alkalai, salt spray and severe weather conditions. Four basic coating types are described, along with data on possible application, methods of applying and temperature ranges.

(21) Arc Furnace Equipment

A bulletin on electrical equipment for arc furnaces has been issued by General Electric Co. The bulletin includes product information and features of arc furnace equipment. Illustrations and information in the bulletin cover transformers, switchgear, control and direct-current motors. (Bulletin GEA-6351)

(22) Lubricated Plug Valves

A new 28-page catalog showing 100 per cent pipe area, venturi, round port, and diamond port lubricated plug valves in a variety of metals for 150 lb steam working pressure, 200 lb oil-water-gas, and A.S.A. 150 and 300 lb classes has been published by the Homestead Valve Manufacturing Co. Complete with engineering dimensions, this catalog also shows different types of power operators for valves,

in addition to complete lines of lever operated, and worm and gear operated valves.

(23) Indicators and Recorders

Concise information about the compact, electronic Speedomax H indicators and recorders now available for precise measurement of rotational or linear speeds, and about the tachometer generators used with them, is presented in an illustrated two-page data sheet just published by Leeds & Northrup Co. This sheet completely lists the features and specifications of the indicators and round- and strip-chart recorders, and tabulates the characteristics and speed ranges of both standard and explosion-resistant tachometers. (Data Sheet ND46-27(100))

(24) Platform Trucks

Specifications and drawings of their low-lift platform electric-driven industrial truck are given in a four-page bulletin released by Automatic Transportation Co. Cut-away drawings of the truck and its features are also included.

(25) Refractory Materials

A new eight-page condensed catalog presenting their line of fired refractory materials has just been published by Richard C. Remmey Son Co. The new catalog covers 19 standard brands of Remmey refractory brick. To simplify refractory selection, the catalog lists the "classification," "properties" and "applications" of each brand. Also presented are brief descriptions of other Remmey products: special refractory shapes; cement, including mortars, ramming mixes, plastics and castables; catalyst carriers, heat exchange pebbles; and the company's line of furnaces and kilns. The bulletin uses photographs to illustrate the company's principal refractory brands, the grading of grog sizes into seven splits for precise control of quality, and a number of special refractory shapes and compositions. Tabular material includes a mortar selection chart for the various refractory brands and a data chart giving more detailed information on mortars. (Bulletin RB-20)

(26) Infra Red Analyzers

Leeds & Northrup Co., has published a folder that discusses the application of their infra red equipment to monitor CO, CO_2, or CH_4: content of metallurgical atmospheres. The publication describes continuous measurement of these gas components from the output of endothermic or exothermic generators or in the furnace itself. Illustrations of typical chart records are shown as well as schematic diagrams of typical applications and a description of the equipment. (Folder N-91-620(1))

(27) Tools

A new bulletin that pictures and describes various types of tools designed and built specially for unusual requirements has been released by Cowles Tool Co. The bulletin describes various types of slitting knives, trimming knives, roll forming tools, tube mill tools, etc. (Bulletin No. 561)

(28) Liquid Oxygen Cylinder

A new type of liquid oxygen cylinder is described in a folder released by Linde Air Products Co. The folder illustrates the cylinder and lists its advantages. Additional features of this new unit are also included.

(29) Mercury Arc Rectifiers

Design features of mercury arc rectifiers are described in a new bulletin released by Allis-Chalmers Manufacturing Co. Included in the bulletin are cross section views of a typical sealed tube and of a pump evacuated excitron rectifier tube. (Bulletin 12B8494)

(30) Reciprocating Pumps

Designed as a quick reference for engineers, production and management personnel is a data sheet from Aldrich Pump Co. which gives complete information on their 25-hp to 2400-hp direct flow pumps. This four-page brochure features Aldrich triplex (3 plunger), quintuplex (5 plunger), septuplex (7 plunger), and nonuplex (9 plunger) reciprocating pumps. It also describes and illustrates the "Power-Savr" pump's stepless, straight-line control of capacity—from zero to rated output without any change in speed of power source. Also presented are dimension tables and a pump selection chart for the complete company line. (Data sheet 100)

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IRON & STEEL ENGINEER

1011 EMPIRE BUILDING

PITTSBURGH 22, PA.

PUBLICATIONS CURRENTLY OFFERED by Iron and Steel Engineer Advertisers

ITEM	COMPANY	BULLETIN	DESCRIPTION
50	ADALET MANUFACTURING CO., THE	BULLETIN F	Cast aluminum housings.
51	ADAMS CO., INC., R. P.	BULLETIN 909	Automatic filters.
52	AIR REDUCTION CO., INC.	BULLETIN ADR 97	Mechanized oxygen cutting equipment.
53	AMERICAN BRIDGE DIVISION, UNITED STATES STEEL CORP.		Heroult electric furnaces and installation data.
54	ATLAS CAR AND MANUFACTURING CO.	BULLETIN 1283	Transfer cars.
55	BLISS CO., E. W.	CATALOG 40-A	Rolling mills.
56	BUFFALO FORGE CO.	BULLETIN FD 205	Radial blade fan.
57	CHEMICAL CONSTRUCTION CORP.		Venturi scrubbers.
58	CROUSE-HINDS CO.		Conduits.
59	CUNNINGHAM CO., M. E.	CATALOG 100	Nail identification tags.
60	DE LAVAL STEAM TURBINE CO.	BULLETIN 1004	Centrifugal pumps.
61	DODGE MANUFACTURING CORP.	BULLETIN A-620	All-steel pillow blocks.
62	EICHLEAY CORP.		Eichleay services to the industry.
63	ELECTRIC CONTROLLER & MFG. CO., DIVISION SQUARE D CO.	BULLETIN 921-6.0	Dynamic braking control.
64	ESTERLINE-ANGUS CO., INC., THE	CATALOG CC854A	Recording instruments.
65	EUCLID ELECTRIC & MFG. CO.	BULLETIN 4400-4401	Controllers for cranes.
66	FARVAL CORP., THE	BULLETIN 26-R	Centralized lubrication.
67	GEAR GRINDING MACHINE CO., THE		Constant velocity universal joints.
68	GENERAL ELECTRIC CO.	GEA-6127	D-c drives.
69	HERR EQUIPMENT CORP., THE	BULLETIN NO. 561	Processing and handling equipment.
70	HUNT AND SON, INC., C. B.	BULLETIN No. 531	Hydraulic valves.
71	KOPPERS CO., INC., FAST'S COUPLINGS DEPT.		Couplings.
72	KOPPERS CO., INC., FREYN DEPARTMENT		Stove valves.
73	LECTROMELT FURNACE CO.	CATALOG 9B	Furnaces.
74	LINK-BELT CO.	BOOK 2416	Belt conveyor idlers.
75	LINDE AIR PRODUCTS CO., UNION CARBIDE AND CARBON CORP.		Powder-cutting blowpipe.
76	LOEWY-HYDROPRESS DIVISION, BALDWIN-LIMA-HAMILTON CORP.	BULLETIN 14002	Complete services for mills.
77	LUBRIPLATE DIVISION, FISKE BROTHERS REFINING CO.		Lubrication.
78	MANSAVER INDUSTRIES, INC.		Grabs.
79	MICHIGAN TOOL CO., CONE-DRIVE GEARS DIVISION	BULLETIN 600C	Worm gear speed reducers.
80	MINNEAPOLIS-HONEYWELL REGULATOR CO.	CATALOG 1531	Electronik controls.
81	MURRAY MANUFACTURING CO., D. J.		Heaters.
82	NATIONAL CARBON CO., UNION CARBIDE AND CARBON CORP.		Carbon physics research.
83	NORTH AMERICAN MFG. CO.	BULLETIN 4545	Gas burners.
84	PANGBORN CORP.	BULLETIN 608	Descaling machines.
85	PARKER APPLIANCE CO., THE	BULLETIN NO. 4402 & CATALOG NO. 4301	Tube and hose fittings.
86	PENNSYLVANIA ENGINEERING CORP.		Service catalog.
87	PITTSBURGH ENGINEERING & MACHINE CO.		Portable ingot stipper.
88	POST-GLOVER ELECTRIC CO., THE		Standard and welded resistors.
89	RAMTITE CO., THE		Castable and gunning refractories.
90	ROLLWAY BEARING CO., INC.		Roller bearings.
91	SPRAYING SYSTEMS CO.	CATALOG NO. 24	Spray nozzles.
92	STEARNS ELECTRIC CORP.	BULLETIN 35-C	Lifting magnets.
93	SUTTON ENGINEERING CO.	BULLETIN NO. 25	Straighteners.
94	TAYLOR INSTRUMENT COMPANIES	BULLETIN 98265	Electronic contact controller.
95	TECHNO CORP.		Check valves.
96	TRABON ENGINEERING CORP.		Lubrication systems.
97	UNITED STATES GRAPHITE CO., THE	ENGINEERING HANDBOOK B-56	Brushes.
98	WAGNER ELECTRIC CORP.		Industrial motors.
99	WALDRON CORP., JOHN	CATALOG 57	Couplings.
100	WATERBURY-FARREL FOUNDRY & MACHINE CORP.		Rolling mills and auxiliary equipment.
101	WESTINGHOUSE ELECTRIC CORP.	B-6072	Drives for processing lines.
102	WHEELABRATOR CORP.	BULLETIN 128D	Mechanical descaling.
103	YODER CO., THE		Cold roll forming.

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PITTSBURGH 22, PA.

new U.S. Steel Research Center installs LOEWY rolling mills

2-high reversing 21" by 30" hot mill for blooming, break-down and finishing. Maximum load 1,000,000 lbs.

4-high reversing 9" and 21½" by 16" cold mill for rolling flats. Maximum load 1,400,000 lbs. Both mills have front and rear tables with adjustable side guards.

Our rolling mills are built to individual requirements. We render complete services from planning to full operation. We build blooming mills, merchant mills, continuous billet and sheet bar mills, continuous strip mills, continuous merchant and wire rod mills, rail and structural mills, skelp mills, high-speed cold sheet and strip mills, high-speed foil mills, special mills and auxiliary equipment for steel, light metals, copper and brass. For bulletin 14002, write Dept. 417, Loewy-Hydropress Division, BLH Corporation, 111 Fifth Avenue, New York 3, New York.

BALDWIN BLH LIMA-HAMILTON

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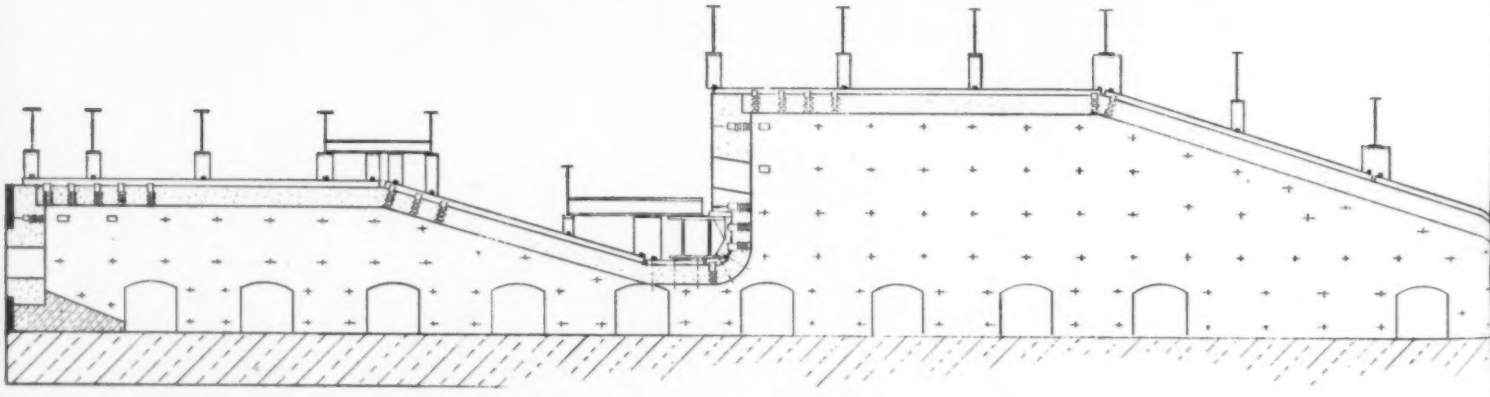
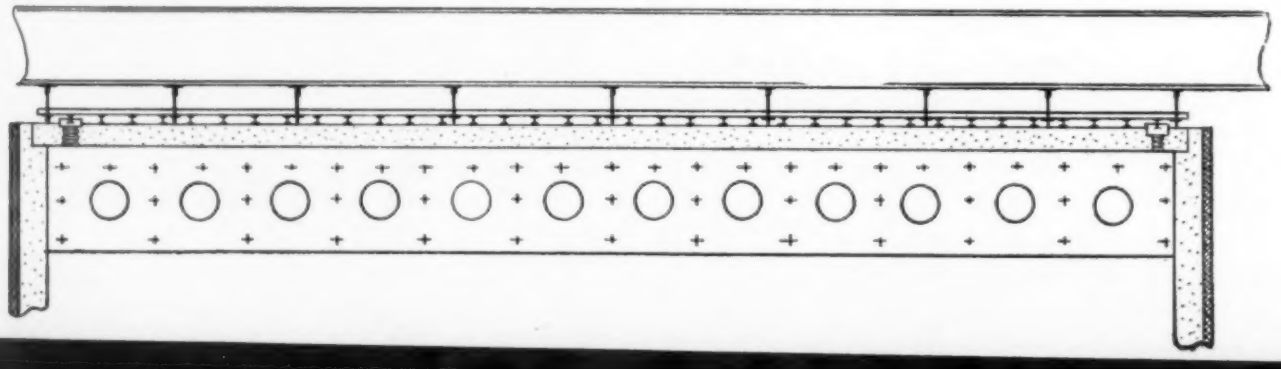
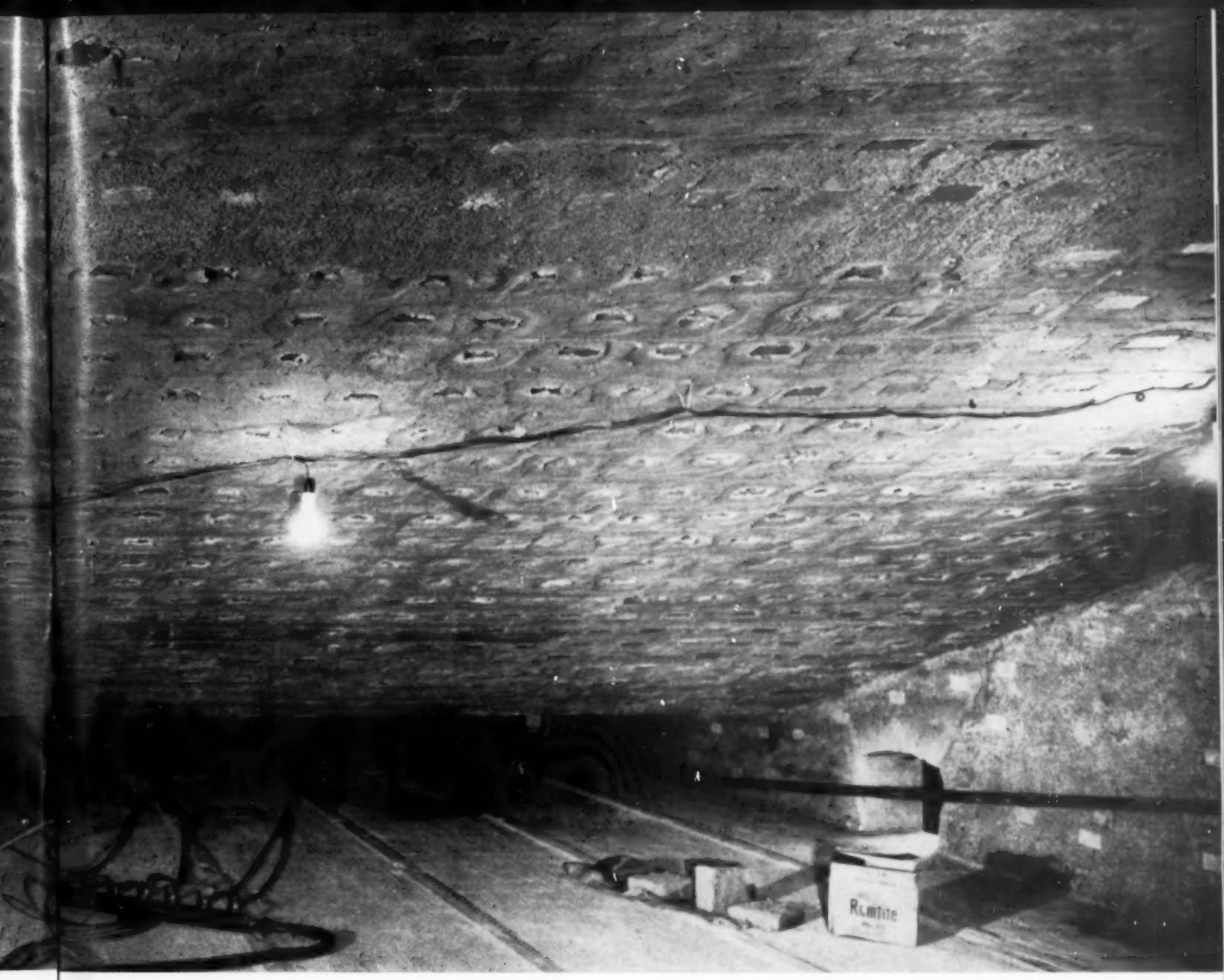


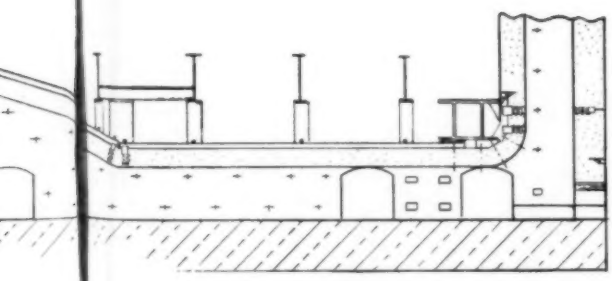




No one but RAMTITE®

ever enclosed a double fired billet mill furnace this large!

85' 6" long by 38' 4" wide overall at Northwestern Steel & Wire Co., Sterling, Illinois.



Here is a huge furnace—one of the largest—completely lined with Ramtite Plastic Refractory.

Whatever your furnace requirements, you can depend on Ramtite products and Ramtite service. For further information, contact your local Ramtite representative or mail the coupon below.

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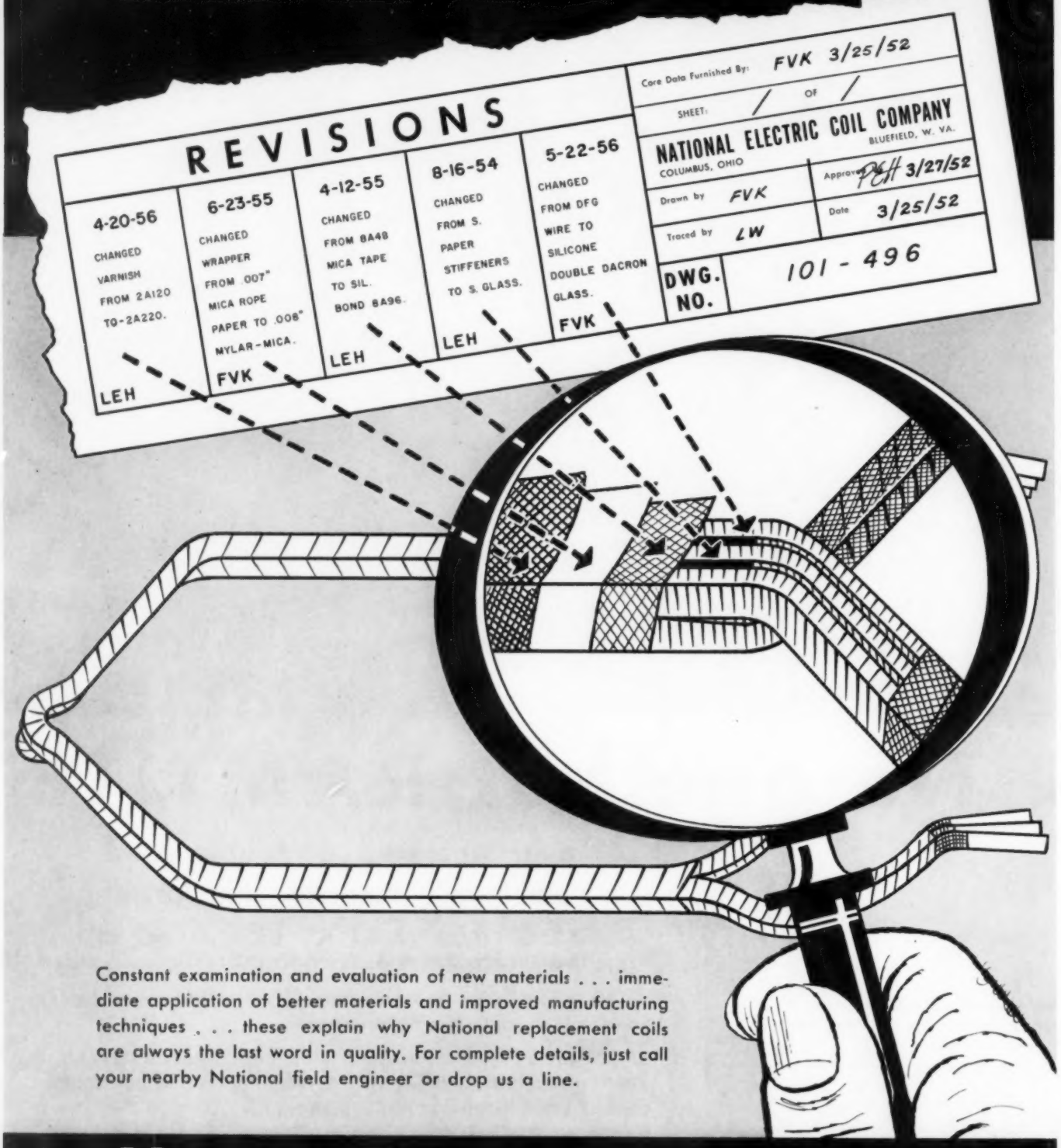

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COLUMBUS 16, OHIO, U. S. A.

ELECTRICAL ENGINEERS: MAKERS OF ELECTRICAL COILS AND INSULATION—
REDESIGNING AND REPAIRING OF ROTATING ELECTRICAL MACHINES

America's

Best Known

LADLES..

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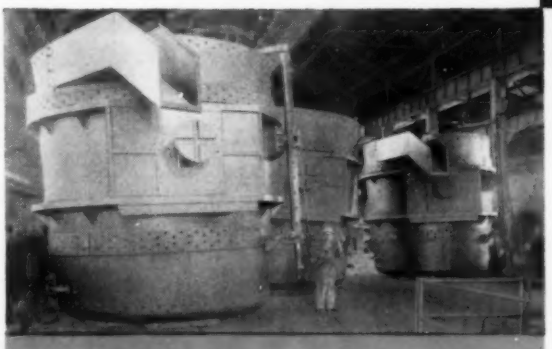
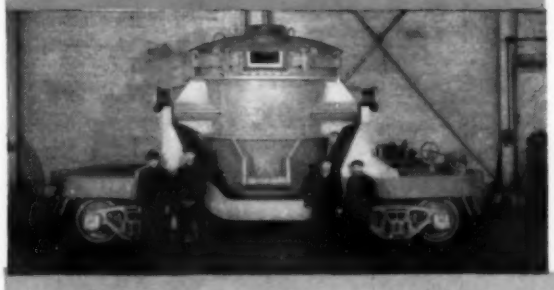
Photo courtesy Jones & Laughlin Steel Corporation, Pittsburgh, Pa.



The superior strength of PECor ladles permits many customers heavy overloads without danger, and capacities are often increased with inexpensive extension of top or bottom shell sections.

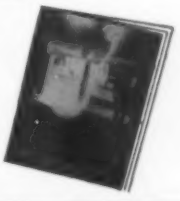


Elimination of horizontal shell plate welds adds strength and service life

Hundreds of PECor ladles—many designed and fabricated to individual specs—are in use daily in steel and other metal producing plants across the country. These range in size from 5-ton "midgets" to the largest used today. They represent many original and sound advances by PECor engineers.

Without obligation, we will be glad to consult with you about a PECor ladle built to your exact needs.

Ask about our new special design *light weight* ladles.



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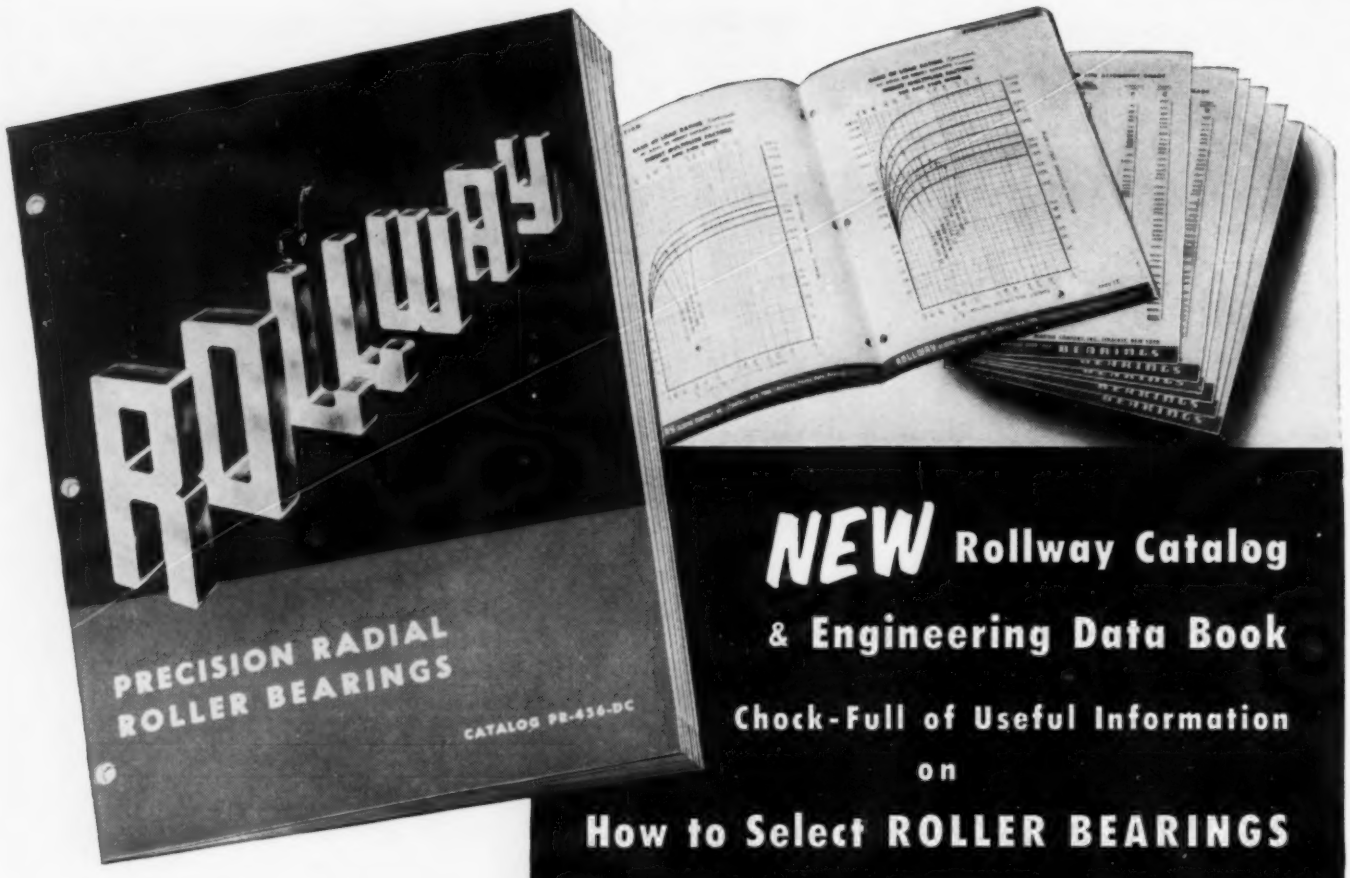

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Chock-Full of Useful Information on How to Select ROLLER BEARINGS

- **Reflects latest RBEC* standards and formulas, PLUS the latest research of Rollway engineers.**
- **Contains the following important data on precision radial roller bearings . . .**

CAPACITIES Detailed information on radial static capacities, radial dynamic capacities, and thrust capacities of cylindrical radial bearings.

Thrust capacities and radial dynamic capacities are given separately. Thrust load does *not* reduce radial capacity nor life expectancy of bearing: It is not necessary to calculate an "Equivalent Radial Load."

APPLICATIONS Load ratings, radial internal clearances temperature allowances, provision for float, alignments, seals, lubrication, etc. . . . all are thoroughly covered, supplemented by engineering drawings of typical applications.

NOMOGRAMS The RBEC* formula is here converted into simple nomogram charts, eliminating complicated selection procedures. You can find in seconds the proper bearing for your application.

PRECISION TABLES Detailed data shows the tolerances achieved with varying degrees of precision. Complete tables include limits for shaft diameters and housing bores to obtain proper type of fit of inner and outer races for various operating conditions.

*Roller Bearing Engineers' Comm.—Anti-Friction Bearing Mfrs. Assn.

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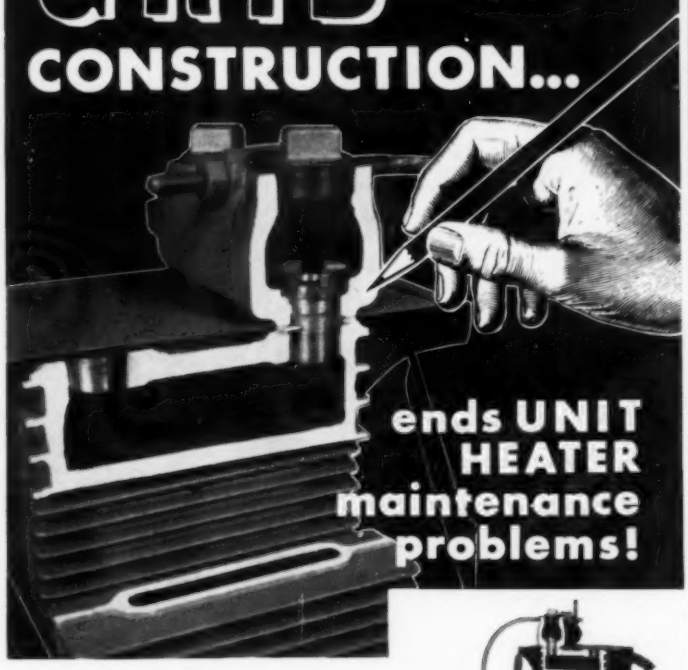
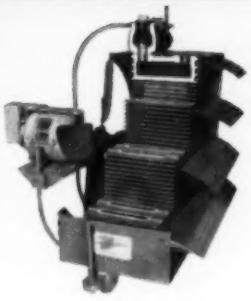
GRID CAST IRON CONSTRUCTION...



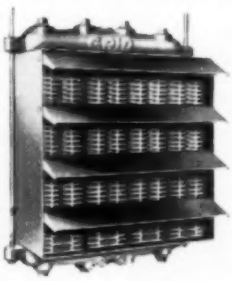


Corrosion in unit heaters — external, from contaminated air . . . internal, from electrolytic action *ENDS* — when your unit heaters are GRID cast iron construction. Here's why—GRID heating sections are made of high-test cast iron . . . no external corrosion from acid or other fumes present in many plants.

All metals in contact with steam are similar . . . no electrolytic action internally . . . no internal corrosion.

GRID construction ends your unit heater maintenance problems — because GRID will operate on steam pressures up to 250 P.S.I. . . . 450° temperature . . . no pressure-reducing valves needed. No soldered, brazed, welded or expanded connections . . . a specially designed threaded nipple provides a leak proof joint (see illustration).

GRID design gives you maximum heating performance because — GRID provides more air changes at lower outlet temperatures . . . carefully selected motor speeds and fan capacities positively deliver warm, comfortable air in ample volume to floor level . . . no wasted heat through stratification.



GRID installations save you money as GRID requires no maintenance . . . is practically self-cleaning (note wide fin spacing in illustration). GRID provides long service life . . . units installed in 1929 are still operating. No ordinary unit heater approaches GRID's record for continuous trouble-free heating service.

Get the complete story on GRID Unit Heaters, GRID Blast Heaters and GRID Radiation for steel mill and blast furnace use. Write for your copy today.

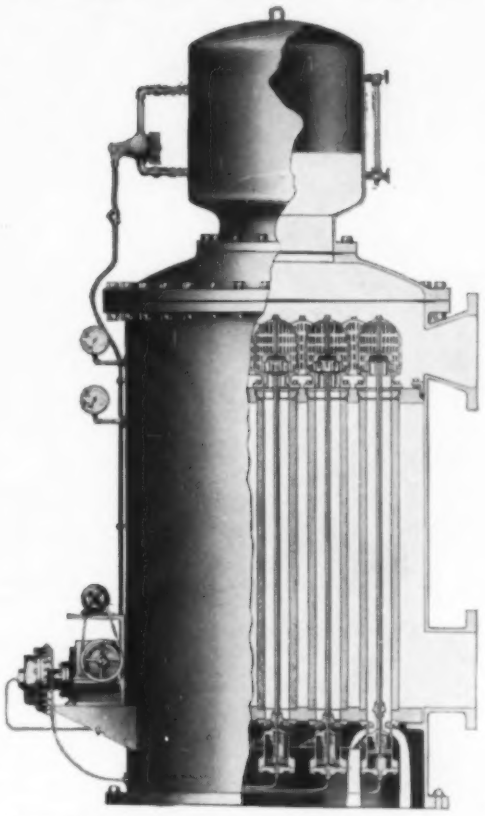
D. J. MURRAY MANUFACTURING CO.

Manufacturers Since 1883

WAUSAU, WISCONSIN

AN ADAMS AUTOMATIC FILTER GIVES YOU...

- CONTINUOUS FILTRATION
- LOW LABOR COST



Automatically each filter tube of the Adams AWF filter is backwashed individually and in sequence. Thus, you get a steady supply of filtered water . . . 24 hours a day . . . without a special operator.

A constant supply of filtered water is delivered by the Adams AWF filter because it is automatically backwashed . . . tube by tube. Since it is fully automatic, no operator is required.

The AWF is available with three types of operating elements . . . *Poro-Stone, Poro-Screen,* and *Poro-Edge* . . . giving you particle separation from 0.0005″ up to 0.0313″ (1/32″). There are three basic sizes with 63, 95 and 116 square feet of filter area. Single and multiple installations give a wide range of capacities to meet your system requirements.

For full details on the Adams AWF which may give you some ideas of how you can benefit from its use, use the coupon below to write for our new Bulletin 909.

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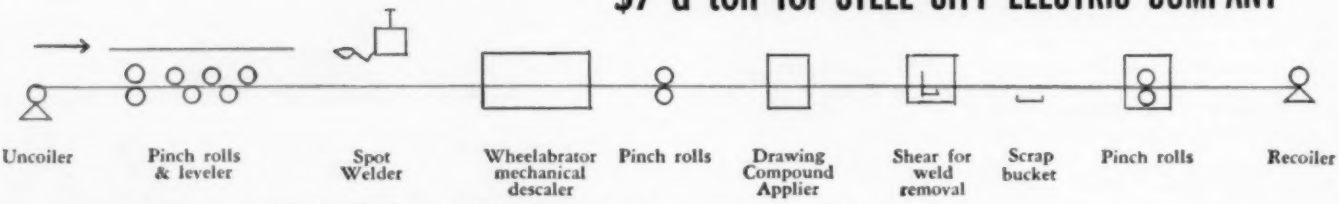
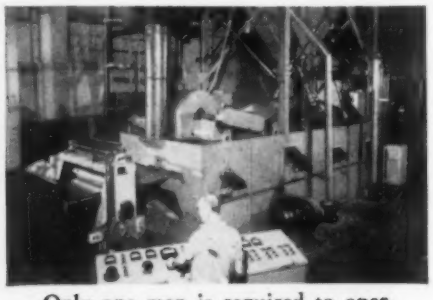
How much would you SAVE in one year by *cutting steel costs* $7 a ton?

Wheelabrator® Mechanical Descaling saves $7 a ton for STEEL CITY ELECTRIC COMPANY



Schematic Diagram: Strip Cleaning Line, Steel City Electric Company



Only one man is required to operate the mechanical descaling line at Steel City Electric Co.

Strip is Wheelabrated prior to stamping and electrogalvanizing of electrical products.

Cleaning hot rolled 1010 steel strip in a Wheelabrator mechanical descaler for $3 a ton has brought big savings for Steel City Electric Company of Pittsburgh, which was paying a premium of $10 a ton for pickled steel from the mill. The $3 figure includes the operating cost for all equipment in the cleaning line. Cleaning strip up to 48" wide and from .060" to .1875" thick, the Wheelabrator descaler cleans an average of 50 tons of steel in an 8-hour day — a potential saving of $350 in steel costs every 8 hours. Don't let saving like this pass you by — investigate Wheelabrator mechanical descaling today. Find out how it can be tailored to your specific needs.

For more information on Wheelabrator savings for steel processors, write today for Bulletin 128D.

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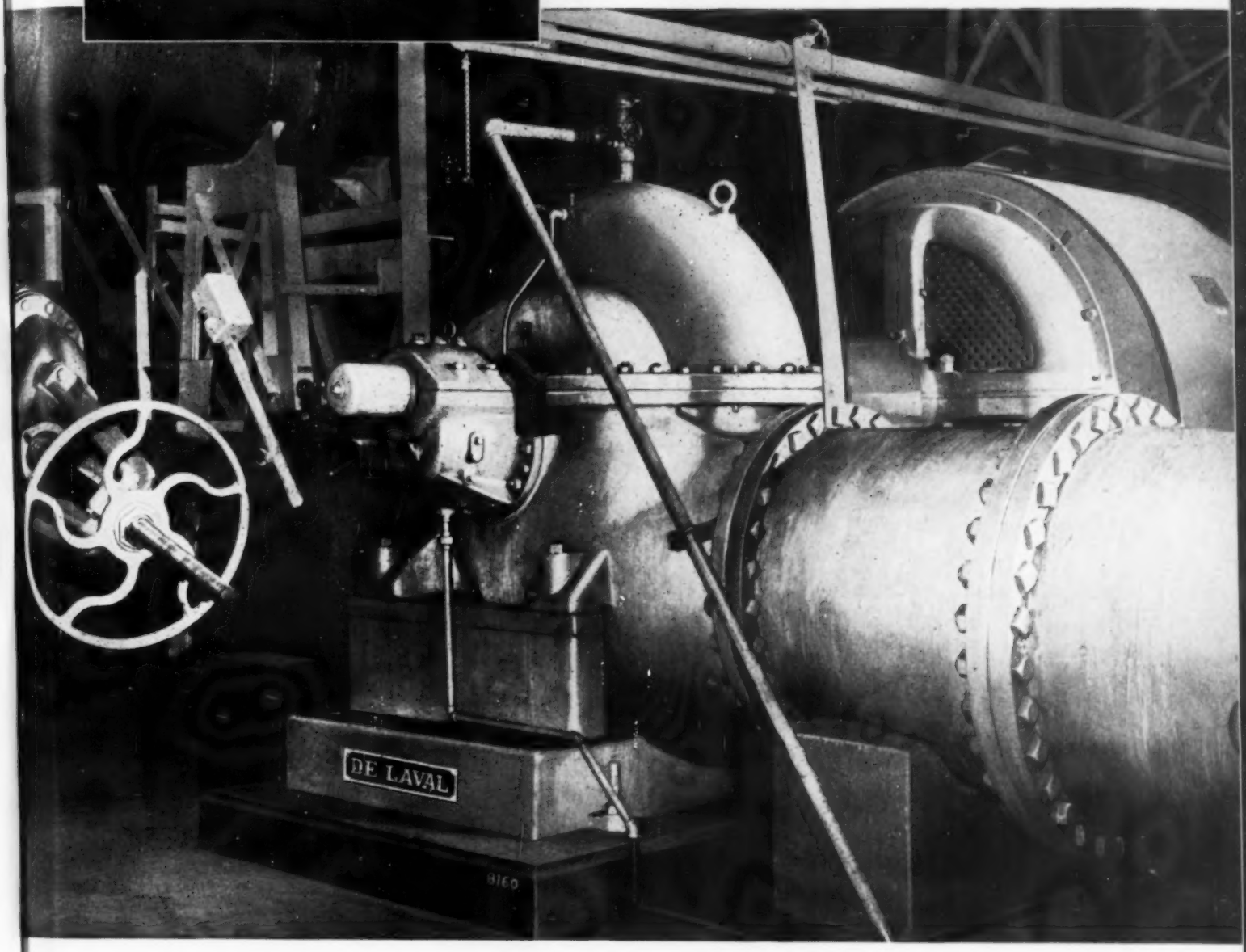
DE LAVAL
CENTRIFUGAL PUMPS

in service since 1911 at Inland Steel Co.



De Laval Centrifugal Pumps have a record of dependability at the Inland Steel Co., which goes back forty-five years. In that time, De Laval has supplied this major producer with pumps for practically every steel mill service—*more than 75 units in all.* The photograph shows one of the largest De Laval pumps on the line at the East Chicago, Indiana plant of Inland Steel. The unit delivers 20,000 gpm at 120 ft head.

De Laval Centrifugal Pumps are available for a wide range of applications in all types of metal-working plants. Types L, M and P single stage double suction pumps can handle capacities from 1,000 to 20,000 gpm and heads to 350 feet. Larger De Laval units of any capacity to meet any requirement for steel mill service are available.

Send for Bulletin 1004 giving performance and application data.

DE LAVAL *Centrifugal Pumps*

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870 Nottingham Way, Trenton 2, New Jersey

at last . . . the solution to

really tough gas-cleaning problems

Sub-micron fumes are the *really tough* problems in gas cleaning. These fumes cannot be economically or effectively controlled by conventional cleaning devices.

However, the CHEMICO P-A VENTURI SCRUBBER is proving its success in solving these *really tough* problems in more than 150 commercial installations and in more than 70 pilot investigations.

The table lists some of these commercial installations. All of these *really tough* problems and many more are being solved with complete satisfaction to users of P-A VENTURI SCRUBBERS.

PROCESS	DUST OR FUME	INSTALLED CAPACITY CFM
Incinerator—Flue Fed	Fly Ash	32,000
Incinerator—Sodium Disposal	Na_2O	9,000
Incinerator—Industrial	Radioactive Dust	6,000
Dry Ice & CO_2 Plants	Amine Recovery	72,400
CO_2 Gas for Process	Fly Ash	500
Boiler Flue Gas	Fly Ash & SO_2	4,300
Enamel Frit Furnace	Dust & HF	11,900
H_2SO_4 Concentrator	H_2SO_4	49,800
Copperas Roasting	H_2SO_4	34,250
Cobalt Ore Roasting	H_2SO_4	65,000
Chemico Wet Type Acid Plant	H_2SO_4	41,000
Chloro-Sulfonic Plant	H_2SO_4	600
Phosphoric Acid Plant	H_3PO_4	91,900
Phosphoric Acid Concentrator	H_3PO_4	194,000
Phosphor Copper Furnace	H_3PO_4	15,000
Smelting—Non-Ferrous		
Blast Furnace	Lead & Organic	12,000
Reverb. Furnace	Lead Compounds	23,500
Comb. Blast & Reverb.	Lead Compounds	7,000
Brass Furnace	Zinc Oxide	7,500
Ajax Furnace	Beryllium Fumes	4,000
Steel Plant		
Oxygen Steel Process	Iron Oxide	140,000
Blast Furnace	Coke & Iron Oxides	788,000
Zinc Sintering	Zinc Oxide	75,000
Wood Distillation	Tar Products	3,500
Na_2SiF_6 Dryer	SiF_4 & Dusts	700
Iron Chloride Concentrator	$FeCl_2$ & HCL Mist	40,000
Unknown	Carbon Black	1,700
Lime Kiln	Lime & Na_2O	18,000
Detergent Spray Dryer	Chemical Fume	250,000
Furfural Residue Burner	Fly Ash	36,000
Nodulizing Kiln	Manganese & Lead	25,000
Aluminum Pot Lines	Tar Fog, Fluorides	40,000
Carbide Furnace	Metal Oxides	1,000
Asphalt Plant	Rock Dust	80,000

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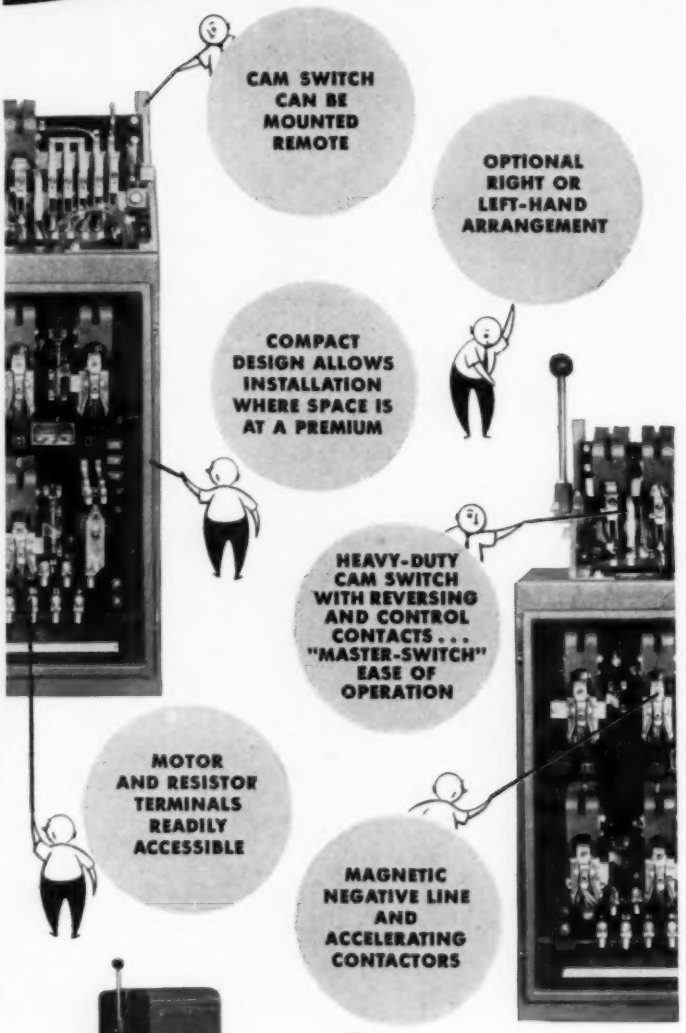
HEAVY-DUTY D-C MAN-NETIC CONTROLLERS*

COMBINATION MANUAL and MAGNETIC CONTROLLER FOR CRANES—CHARGING MACHINES—D-C CONTROL JOBS


CAM SWITCH CAN BE MOUNTED REMOTE
OPTIONAL RIGHT OR LEFT-HAND ARRANGEMENT
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HEAVY-DUTY CAM SWITCH WITH REVERSING AND CONTROL CONTACTS . . . "MASTER-SWITCH" EASE OF OPERATION
MOTOR AND RESISTOR TERMINALS READILY ACCESSIBLE
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2 TYPES AVAILABLE: REVERSE-PLUGGING OR DYNAMIC - LOWERING

Provide four speed points, reversing, with all advantages of full-magnetic control. Manually-operated cam contacts are free of destructive arcing . . . extremely fast magnetic contactor action interrupts power circuit before cam-operated contacts are opened. EUCLID'S EXCLUSIVE "TIMELOK" feature offers maximum dependable acceleration timing without extra relays . . . permits unusually compact arrangement of the magnetic panel.

For more information, contact our representative in your area, or write or call THE EUCLID ELECTRIC & MFG. CO., MADISON, OHIO.

Ask for Bulletin 4400-4401.

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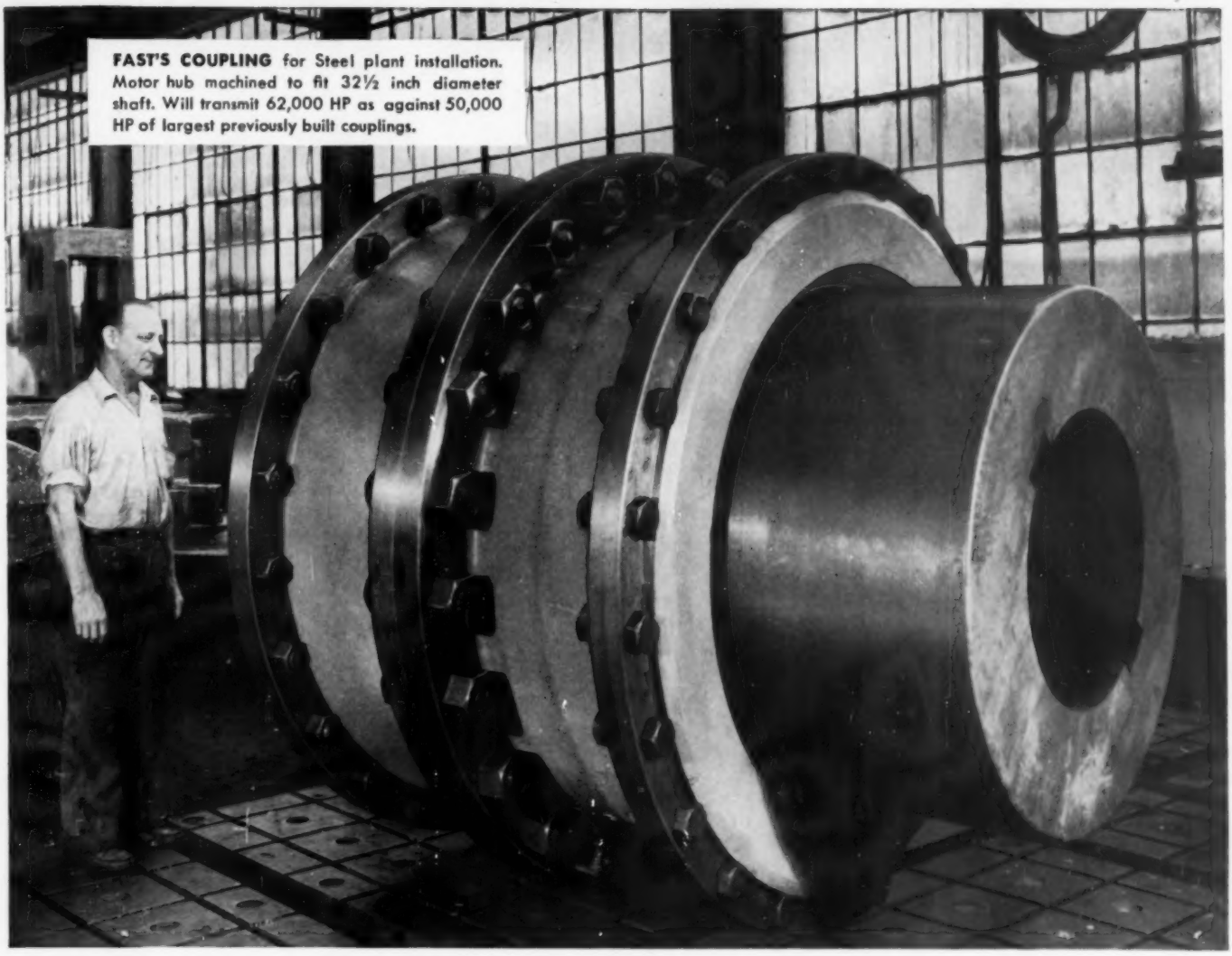

FAST'S COUPLING for Steel plant installation. Motor hub machined to fit 32½ inch diameter shaft. Will transmit 62,000 HP as against 50,000 HP of largest previously built couplings.

WORLD'S LARGEST INDUSTRIAL GEAR-TYPE COUPLING

To make a coupling that will transmit 62,000 HP and compensate for errors in alignment . . . that's more than a man-sized job.

But Koppers took on the project and this Fast's Self-Aligning Coupling is the result.

After six months of machining and assembly, this huge, *all metal* coupling is on its way to installation in a Milano, Italy, steel mill where it will carry power to a Mesta, 110-inch, four-high reversing plate mill.

It will transmit power from an electric motor to the equipment, and, at the same time, compensate for shaft misalignment and lateral float, give maximum power transmission efficiency, eliminate breakdowns and costly down-time.

WHAT'S YOUR COUPLING PROBLEM?

This mammoth Fast's Coupling is just one example of the outstanding jobs which Koppers is equipped to handle. 35 years of manufacturing "know-how" go into the production of *all* Fast's Couplings, large and small alike. Engineering specialists, experienced in designing Fast's Couplings for special applications, are well equipped to solve your coupling problems.

Remember, there's a Fast's Coupling for every power transmission application. Next time you have a coupling problem, call on Koppers . . . always ready to serve you. No obligation, of course. Also, for full details on Fast's Couplings for industry, mail this coupon.

THE ORIGINAL **Fast's Couplings**

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Gentlemen: Send me FREE, Fast's Catalog giving detailed descriptions, engineering drawings, capacity tables and photographs.

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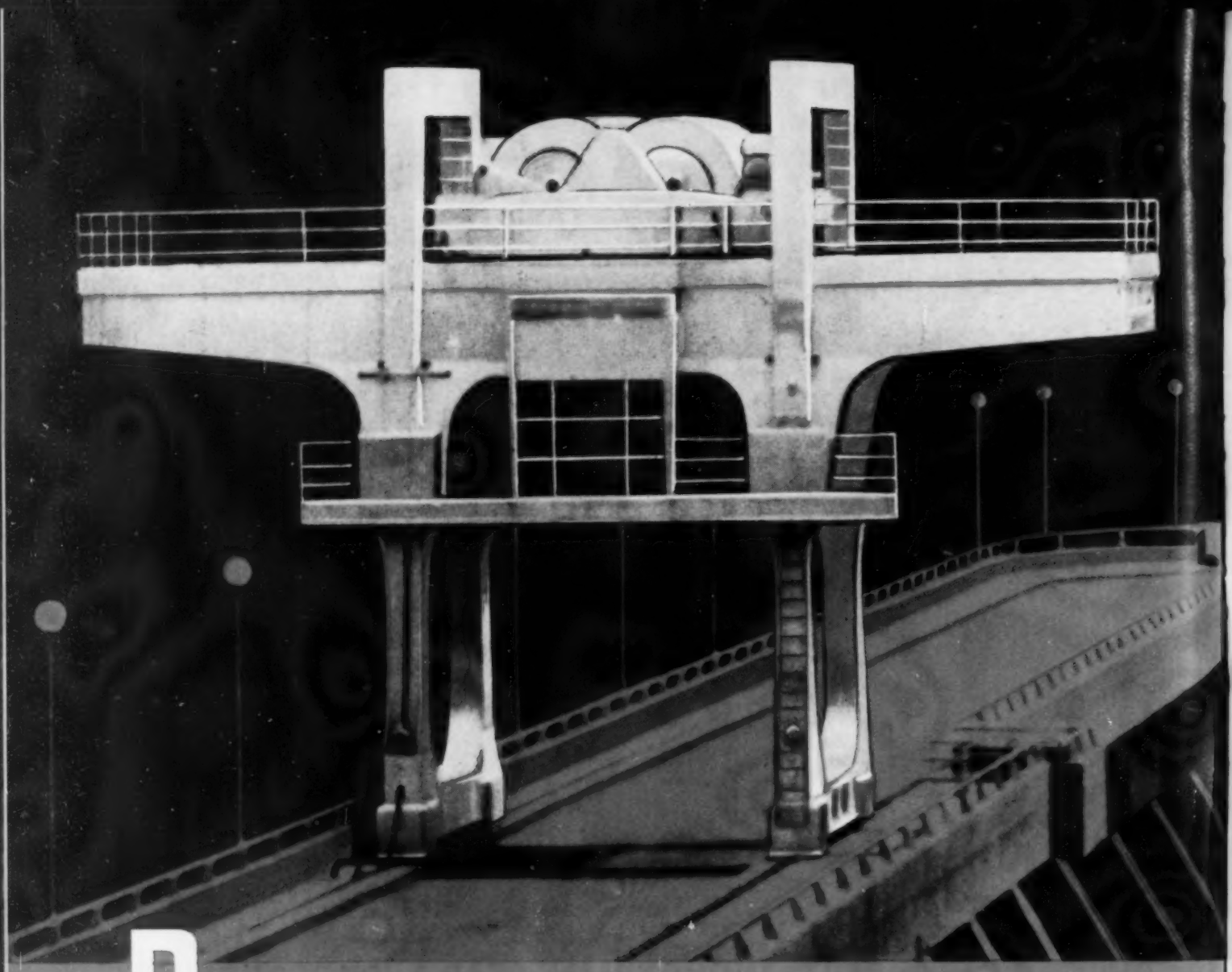

Biggest GANTRY CRANES
in the world

This 120-ton Alliance gantry crane has one of the highest lifts on record—255 feet.

Alliance builds gantry cranes of all sizes and types—stationary, traveling, full, semi and cantilever. These big cranes are designed specifically for the duty they perform in shipyards, construction projects, dams, steel mills, railroad yards and other locations where overhead runways are not suitable.

Check your crane needs with Alliance—world's largest builders of the world's largest cranes. They'll work with you to develop the one crane that meets your needs best.

"Give us the Runway and we'll lift the World"

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Equipment News...

PIPE STRAIGHTENER

▲ The heavy-duty Mackintosh-Hemphill rotary tube straightener has been improved to make larger models of the machine easier to adjust and maintain under adverse operating conditions.

The new design is actually an adaptation of a rigid three-post arrangement of supports between the bed and the top of the machine. Three-post construction has already been widely used on smaller Mack-Hemp straighteners up to the Model AXY for pipe and tube of maximum 1 in. O.D. Larger straighteners previously available only with six threaded posts are now being supplied using the new three-post construction. Included is a Model A-5 for 16 in. electric welded pipe recently shipped to a large eastern steel plant.

Specific advantages of the new construction are that it eliminates possibility of interference between the support ports and the six roll-drive spindles, and that it offers better front access to the roll group. It also makes possible quick roll changing and faster and more certain roll adjustment and roll locking.

Moreover, the bevel-pinion-and-gear-operated screw adjustment that raises and lowers the three top rolls and the bottom-middle roll is fully enclosed, as are the levers and cams that control the rolls' angular position. Thus, roll adjusting mechanisms are protected from scale and water. Little or no maintenance is required to keep them operating easily at all times.

Because their reduced maintenance requirements and the high straightening speeds made possible by driving all six rolls eliminate production "bottlenecking," the new three-post straighteners can be placed literally anywhere in a pipe mill finishing line.

AUTOMATIC STITCHER

▲ Developed by the Herr Equipment Corp. is an automatic stitcher said to permit the leading end of a new coil to be joined to the trailing end of the preceding coil in minimum time; does not require professional or skilled operators; and avoids the high cost usually associated with automatic welding.

The operator aligns the trailing end of the lead coil and the lead end of the new coil in the stitcher with a 3 in. to 5 in. overlap and clamps them tight. The standard 36 in. stitcher automatically joins the two pieces together with 14 locked stitches set in parallel rows 2 in. apart in from 15 to 20 seconds. Movement of the stitching head is interrupted momentarily as each stitch is made to avoid any deformation of the stitch, and to assure the formation of a locked joint having maximum strength.

Load strength of three stitches is said to be equal to joining the two pieces together with a $\frac{1}{8}$ in. steel rivet. The joint is only about $\frac{1}{10}$ in. greater than the total thickness of the two pieces of material joined, passes over rolls easily and can be used at elevated temperatures without difficulty.

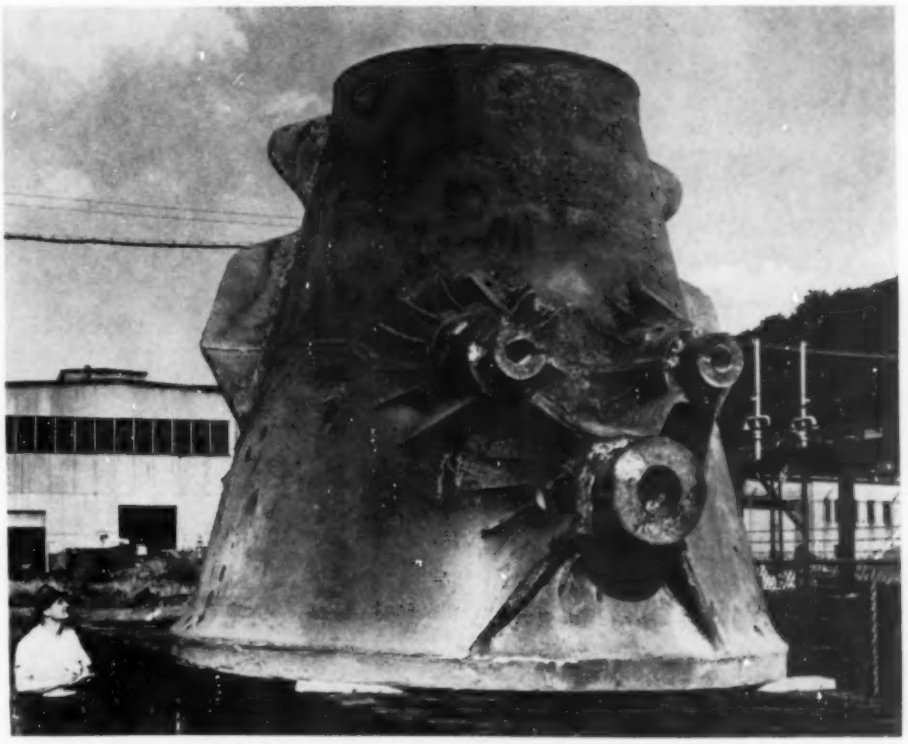
The 36 in. stitcher adjusts itself automatically to stitch narrower than 36 in. wide strip. Stitchers are also available to stitch wider than 36 in. strip. The standard machines are said to be able to stitch together two pieces of .050 C.R.S.; two pieces of aluminum up to .093 and two pieces of copper up to .035. The maximum thickness of material that can be stitched varies with its physical properties.

LIMIT SWITCH

▲ Introduced by the Clark Controller Co. is a heavy-duty machine limit switch designed for long life with minimum maintenance and greater ease in wiring. Features of the Type DM limit switch include increased wiring space, protection against ex-

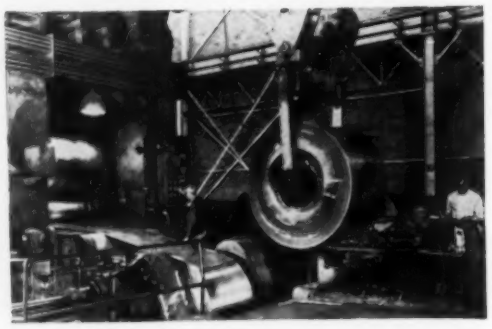
GIANT SLAG POT IS ONE SOLID CASTING

This slag pot, made by Blaw-Knox Co., has a capacity of 480 cu ft and weighs 47,000 lb. It is one of the largest pots ever made, and is one solid casting including the flat bottom and three trunnions on either side. Until a few years ago it was considered impossible to integrally cast a flat bottom into a slag pot. Most of the flat bottom pots in service today, in fact, have the bottom plates bolted to the cast steel body of the pot. Unusual also are the integrally cast trunnions which are normally found on the slag pot cradle rather than the pot.



MANSAVER® GRABS FEED TEMPER MILLS

Handling Coils of Various Widths



Mansaver Grab Style G-1418 operates entirely under the remote control of the man at the right, with no floor assistance.

Its motor-driven arms adjust to coils of various widths, and takes them safely from storage to mill stands. Supplied with twin suspension (as shown), single suspension, or motor-driven turntable. Mansaver Grabs are supplied for handling sheet, wire, rods and bars, as well. Write for catalog and name of our nearest representative.

Mansaver Grabs Are Built To PREVENT
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cessive overtravel achieved without shear pins, complete separation of electrical and mechanical mechanisms, and nylon-to-steel wearing surfaces.

The switch is rated at 10 amperes continuous capacity up to 600 volts a-c, 550 volts d-c. The switch is available with ½ or ¾ in. conduit connections.

The switch has a heavy diecast case with an integral solid wall separating mechanical and electrical mechanisms. On the electrical side, a heavy one-piece molded insulating chamber surrounds all live parts, supports wiring terminals, and shrouds the moving contact arm to prevent fouling by wire leads. Need for use of insulating cloth is eliminated. The inside of the front cover plate and separating wall are protected against arc deterioration by non-carbonizing glass melamine.

Though the case is no longer than other switches of this type, ample space has been provided for four No. 12 wires. Insulated connectors may be used, but multi-level terminals are provided to permit use of uninsulated pressure-type connectors.

All bearing surfaces in latch and trip mechanisms are nylon-to-steel, selected for low coefficient of friction and long wearing qualities. The operating roller arm is also nylon.

The overtravel mechanism has two sets of double-concentric coil springs permitting continuous 30 deg overtravel without increasing maintenance problems or shortening life. These and all other springs are in compression to make operating as nearly "fail safe" as possible. Excessive overtravel is accommodated by slippage between mating serrated discs. Pressure required to slip these discs is many times the normal operating pressure of the switch, but well below that which could damage switch parts. After excessive overtravel the switch can be reset with a screwdriver, with no replacement of parts necessary.

SHEARS

▲ A new series of air-operated shears for cutting ferrous and non-ferrous strip has been developed by Curry Air Shear Corp. Previously air-operated shears were produced only for cutting rounds and other bar stock. Floor space and weight requirements

Wagner ELECTRIC MOTORS...the choice of leaders in industry

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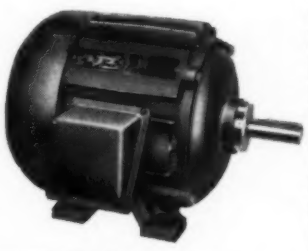
Industrial Motors

lower your maintenance costs—cut down-time

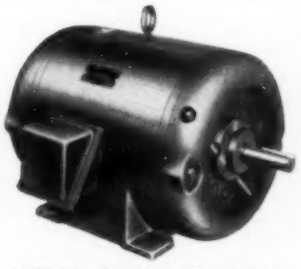
Wagner offers a complete line of protected type motors, specifically designed for use where severe conditions demand EXTRA protection—for bearings or windings... against corrosive vapors or abrasive dirt ...in explosive atmospheres or exposed outdoor locations.

In their specific applications, each of these Wagner Motors assures completely dependable performance—with a minimum of maintenance and a maximum of freedom from costly down-time due to motor failure. Openings are provided for relubrication to greatly prolong bearing life.

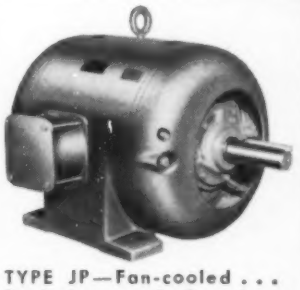
A Wagner engineer, expert on motor applications, will be glad to help you select the *right* motors for your specific needs. Just call the nearest of our 32 branch offices, or write for Wagner Industrial Motor Bulletins.



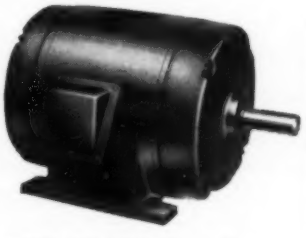
TYPE EP—Ribbed frame fan-cooled. New NEMA Frames. 1 to 30 hp.



TYPE EP—Totally-enclosed fan-cooled. Corrosion-resistant frames. 40 to 250 hp.

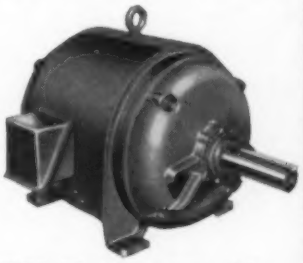


TYPE JP—Fan-cooled . . . Explosion-proof. Cast iron frames. 40 to 250 hp.



TYPE DP—Drip-proof . . . corrosion-resistant. New NEMA Frames. 1 to 30 hp.

TYPE DP—Drip-proof. Cast iron frames. 40 to 125 hp.



TYPE RP—Open-type drip-proof. Welded steel frames. 125 to 500 hp.

WAGNER ELECTRIC CORPORATION
6483 Plymouth Ave., St. Louis 14, Mo., U. S. A.

M56-12

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES • AUTOMOTIVE BRAKE SYSTEMS, AIR AND HYDRAULIC

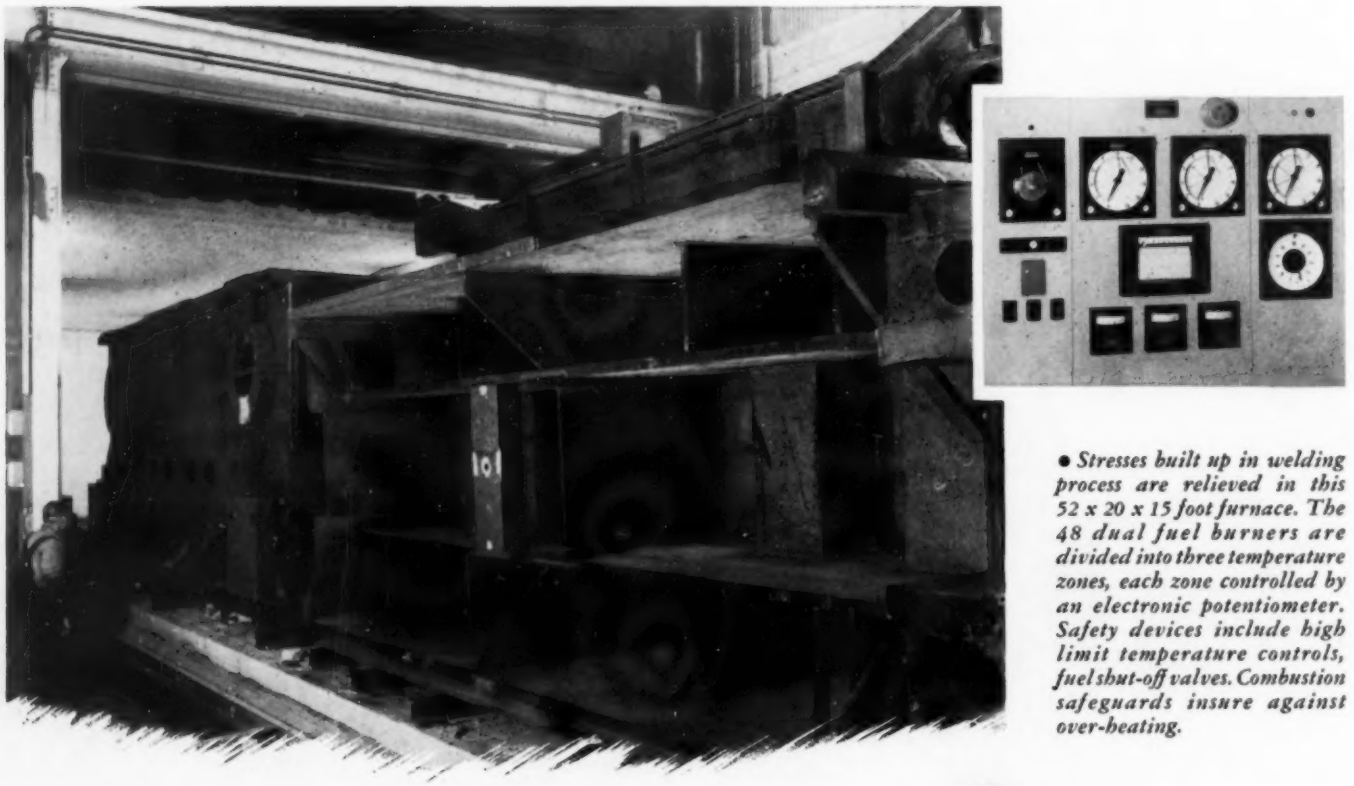
How Morgan stress relieving insures maximum design strength

• STRESS RELIEVING is one of many reasons why Morgan cranes provide longer, completely safe service under *any* operating conditions. Trolley frames, end carriages, trucks, drums, bearing caps, stripper barrels and rams, pit rams . . . all are stress relieved in Morgan's huge furnace capable of handling loads up to 250,000 pounds.

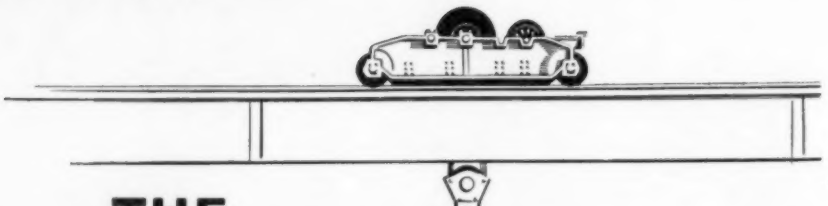
Morgan's stress relief furnace, one of the largest in the world, can raise temperatures 200 degrees Fahrenheit per hour up to 1750° F.

Stress relieving is still another example of the advanced design and construction features that make Morgan cranes the best in the business.

Performance records prove that Morgan cranes cost less to operate and maintain. Let our representative show you how to save the most by buying the best . . . Morgan!



• Stresses built up in welding process are relieved in this 52 x 20 x 15 foot furnace. The 48 dual fuel burners are divided into three temperature zones, each zone controlled by an electronic potentiometer. Safety devices include high limit temperature controls, fuel shut-off valves. Combustion safeguards insure against over-heating.



The Morgan Engineering Company, founded in 1868, manufactures overhead electric traveling cranes, gantry cranes, open hearth special cranes, plate mills, blooming mills, structural mills, shears, saws, and auxiliary equipment.

THE MORGAN ENGINEERING CO. *Alliance, Ohio*

for the shears are at a minimum since no motor, gearing or clutch are required.

These shears are available for cutting strip up to 3/16 in. thick in mild steel and widths from 24 in. to 84 in. They are recommended for cutting hot or cold carbon or stainless steel, copper, aluminum and other metals. The model illustrated is an up-cut type with 40 in. blades for cutting mild steel strip 38 in. x 12 gage or stainless strip 38 in. x .050 in.

These shears are entirely operated by air, with controls furnished to suit customers requirements. Controls may be hand operated, foot operated, automatic, air pilot or solenoid controlled. Shears are furnished complete with air filter, air lubricator, muffler, self-contained hydraulic shock cylinder and set screw adjustment for bottom knife.

FORK TRUCK

▲ An 8000 lb. capacity model with dual drive wheels, the EUT-8024, is the newest addition to Clark Equipment Co.'s line of battery powered fork-lift trucks.

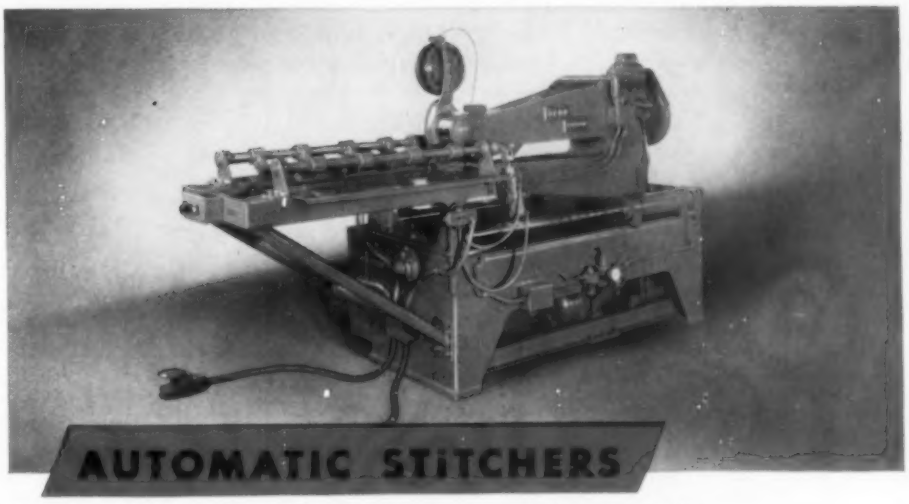
A turning radius of 85 in. aisle for right angle stacking (including 48 in.

long load) of 148½ in. and overall length of 133 in. are dimensional features of the machine. With four speeds forward and four reverse, it will travel loaded at 5½ mph and climb a 10 per cent grade.

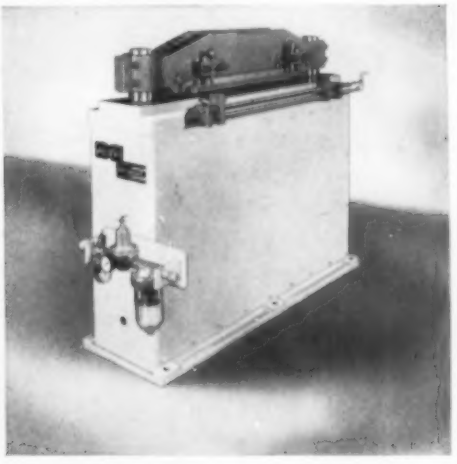
Power comes from a dual field, high-torque motor which provides maximum efficiency under the most severe operating conditions. A fingertip directional control lever on the steering column controls first speed in each direction and mechanically cuts off power and locks in neutral when the operator's seat is empty. Second, third and fourth speeds are attained by a foot accelerator operating a master control switch. The

HERR EQUIPMENT

"Complete Processing and Handling Equipment . . . for any Ferrous or Non-Ferrous Material . . . That Starts — or Ends — as a Coil"



Fast, dependable method of fastening the lead end of a new coil to the trailing end of a preceding coil. Entirely automatic. Produces a double row of locked stitches. Practical for strip of any width. Your samples stitched and returned promptly. Also automatic welders.



Fast acting single shears for use with hump tables in cut-to-length and press feed lines, and other applications to square crop the end of a coil. Also twin cut shears that remove the section where two coils were stitched or welded together for continuous processing.

Write for fully descriptive Bulletin No. 561 today!

THE HERR EQUIPMENT CORPORATION

1270 VINE STREET • WARREN, OHIO

CLEVELAND, INDIANAPOLIS AND BERKELEY, CALIFORNIA

control panel includes magnetically operated contactors providing automatic acceleration with pre-set time delay between each point of power. Plugging and timing relays eliminate excessive current in drive motor during reversal of truck. A switch operated by the brake pedal cuts off power to drive motor when hydraulic brakes are applied.

The truck has three independent braking systems. In addition to hydraulic brakes, a "deadman" brake mounted on the drive motor armature applies automatically when the operator leaves his seat. The machine also can be braked by reversal of power in first speed.

An automatic "tilt-lock" valve in the hydraulic system prevents "drifting" of the uprights under heavy loads. The hydraulic system is controlled by a Vickers "feather-action" spool type sectional valve with built-in pressure relief. Telescopic, axle-mounted uprights are of heavy section alloy steel channel.

PRESSURE TRANSMITTER

▲ A new concept in low-cost flow transmission has been introduced by Taylor Instrument Cos. Hitherto unchecked sources of steam, water and air in departmental consumption can now be easily and economically cost-accounted with the new 200TD fixed range differential transmitter.

The transmitter offers no barrier to control engineer the complete processes in a plant, such as liquid

level, consistency, or low-pressure air or gases (up to 10 psi) requiring sensitive transmission readings to an indicating or recording instrument.

The 200TD measures 6½ in. x 3 in.; weighs 4½ lb., can be pipe mounted; all connections ¼ in. internal NPT; a wrench and screw driver can install and adjust it on stream for zero. Its diaphragm is neoprene-impregnated nylon. Body material is brass. Maximum working pressure; 150 psi; temperature 150 F Air supply pressure 20 psi. Air consumption, 0.10 standard cu fpm. Output pressure range 3 to 15 psi.

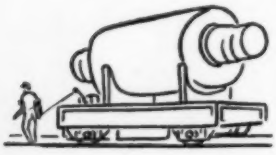
Calibration accuracy is better than 1 per cent. Sensitivity exceeds 0.1 per cent. Ranges: 0 to 50, 100, 200 and 300 in. of water. Indoors or outdoors mounting, it will serve year after year in consistently accurate performance.

SPRAY NOZZLE

▲ A large capacity flat spray nozzle has been announced by Spraying Systems Co. as an addition to its Veejet line. Identified as the 2-U-Veejet, this new nozzle is the largest of its type ever produced by the company.

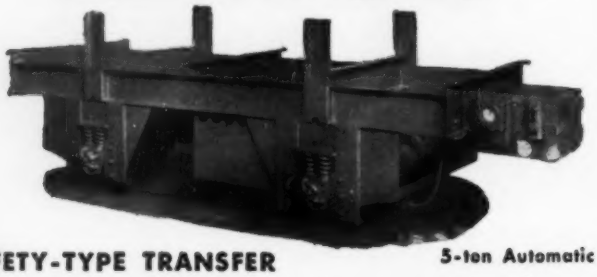
Capacity of this new type nozzle ranges from 73 gpm at 15 psi to 330 gpm at 300 psi. It is supplied in

HANDLES THE BIG LOADS WITH BIG SAVINGS



100-ton Battery Operated

ATLAS *Safety Type* TRANSFERS



5-ton Automatic Controlled

ATLAS SAFETY-TYPE TRANSFER CARS can be provided in almost any capacity for storage battery, diesel or gas-electric, or cable reel service.

They are safe because there is only one control lever, and the car moves only when the operator holds the lever.

Request "Walk-Along" Bulletin 1283.

ATLAS CAR & MFG. CO.
1100 IVANHOE ROAD
CLEVELAND 10, OHIO

ENGINEERS AND MANUFACTURERS SINCE 1896

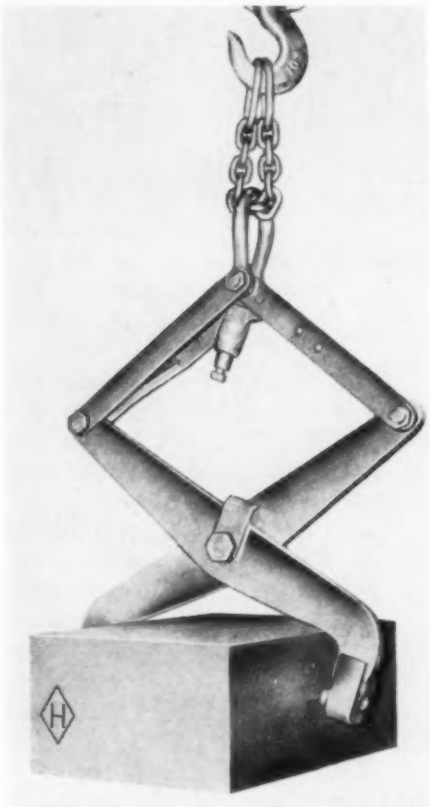
choice of two types of spray angles. The nozzle is designed free of cores, vanes or obstructions of any kind and is made with a 2-in. male pipe connection.

Designed for heavy duty cooling and washing operations, the nozzle is also suitable for other applications where a large capacity flat spray is desired.

AUTOMATIC TONGS

▲ Two sizes of general purpose automatic tongs have been developed by Heppenstall Co. Based on the company's die block tongs, the new tongs are intended for use not only in lifting die blocks, but also for lifting other square, round, and rectangular objects up to their rated capacities.

One pair, designed for loads up to 3,000 lb, has a maximum jaw opening of 18½ in. The tongs have a maximum width of 27½ in. and a shipping weight of 50 lb. The other pair, designed for loads up to 5,000 lb, has a maximum jaw opening of 25 in. The tongs have a maximum width of



37¾ in. and a shipping weight of 110 lb.

Supported by an overhead crane or hoist, the tongs are lowered over the object to be lifted with their jaws locked open. When they are raised again, the jaws close and hold the object firmly while lifting. When the burden is lowered and again rests on a firm surface, the tongs lock open again, ready for another load.

GAS BURNERS

▲ Series "RTG" Burners, developed by Hauck Manufacturing Co., have been designed to provide control of flame length to fit the length of radiant tubes and give better heat distribution. A primary air adjustment feature permits the burner application to a full range of tube sizes.

Because the major portion of combustion air is introduced around the outside of the flame retention nozzle, the burner operates more quietly. This diverted air flow helps prolong combustion over a greater length to get best heat distribution. All of the air for combustion is supplied through the "sealed-in" burner eliminating need for an eductor or exhaust fan. The burner permits a turndown ratio of 5 or 10 to 1.

The burner includes a mounting flange with integral air inlet body, flame length control lever and indicator dial, direct spark ignition for easy, quiet lighting of burner (no pi-

for intense concentration of heat...

The BLOOM HTR BURNER

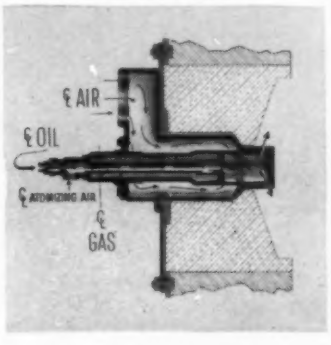
The Bloom HTR Burner provides identical operation on either gas or oil.

This burner enables the engineer to design a heat pattern with excellent results, because it has the unique characteristic of providing localized high heat release with low forward velocity. The burner can be located to fire directly at the material without flame impingement. Roof firing is easily accomplished and provides uniform hearth temperature.

This burner has been very successful in its application to tube upset furnaces; continuous strip annealing, coating, and pre-heating lines; high speed billet heating furnaces; and batch-type forge furnaces.

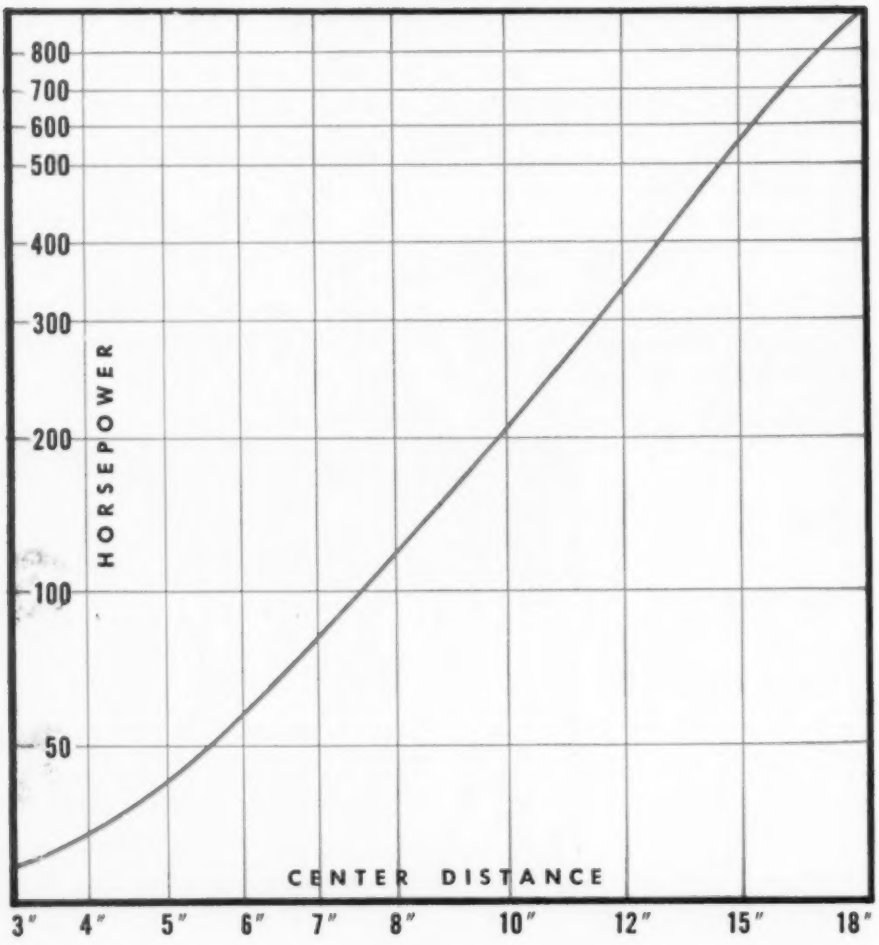
The Bloom High Thermal Release Burner with its sturdy construction is ideal for applications requiring speed and precision heating.

PATENT PENDING



BLOOM ENGINEERING CO., INC.
837 W. North Avenue Pittsburgh 33, Pa.

"DO-IT-YOURSELF"



Prove the difference in worm gear speed reducers yourself. Here's how . . .

. . On this chart we've plotted the mechanical horsepower capacity of Cone-Drive worm gear speed reducers against their center distances. Ratings are for Class I Service with a 5:1 reduction and an input speed of 1750 rpm.

All you have to do is plot the corresponding ratings for the speed reducers you're now using or planning to use. We think you'll be surprised at the results.*

For details on Cone-Drive gearing's double-enveloping design and specifications, ask for Bulletin 600C. We'll send it to you immediately without obligation.

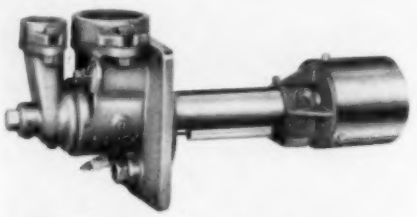
**If you're too busy to "Do-it-yourself", Cone-Drive representatives will be glad to show you filled-in charts.*

CONE-DRIVE GEARS
Division, Michigan Tool Company
DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
7171 E. McNichols Road • Detroit 12, Michigan

lot required), observation port for safe, easy viewing of flame, gas inlet body with primary air mixing adjustment, full flanged gas and air inlets and the burner nozzle assembly. The nozzle has supporting posts to keep it centered in the radiant or immersion firing tube.

The burner may be operated with automatic control of the on-off, high-low or modulating type.

For areas requiring an alternate fuel, the Series "RTD" Dual Fuel Burner is available for either light fuel oil or gas. This combination



burner offers all the merits of gas firing plus oil firing in a burner unit which includes a self-clean metering valve for precision adjustment of oil flow rate and easily duplicated valve settings.

Both types are available in a complete line of burner sizes for tube firing requirements.

IRON POWDER ELECTRODE

▲ A new iron powder electrode, known as Airco Easyarc 10, is now available from Air Reduction Sales Co. It is the first iron powder electrode developed to meet the requirements of the AWS-E-6010 classification.

Using normal techniques and normal arc length, the electrode provides a shallow rippled, smooth weld deposit in all positions including vertical down.

It is suitable for many applications such as tanks with plain or galvanized surfaces, field construction, shipyards, and in particular, areas where out of position welding is encountered.

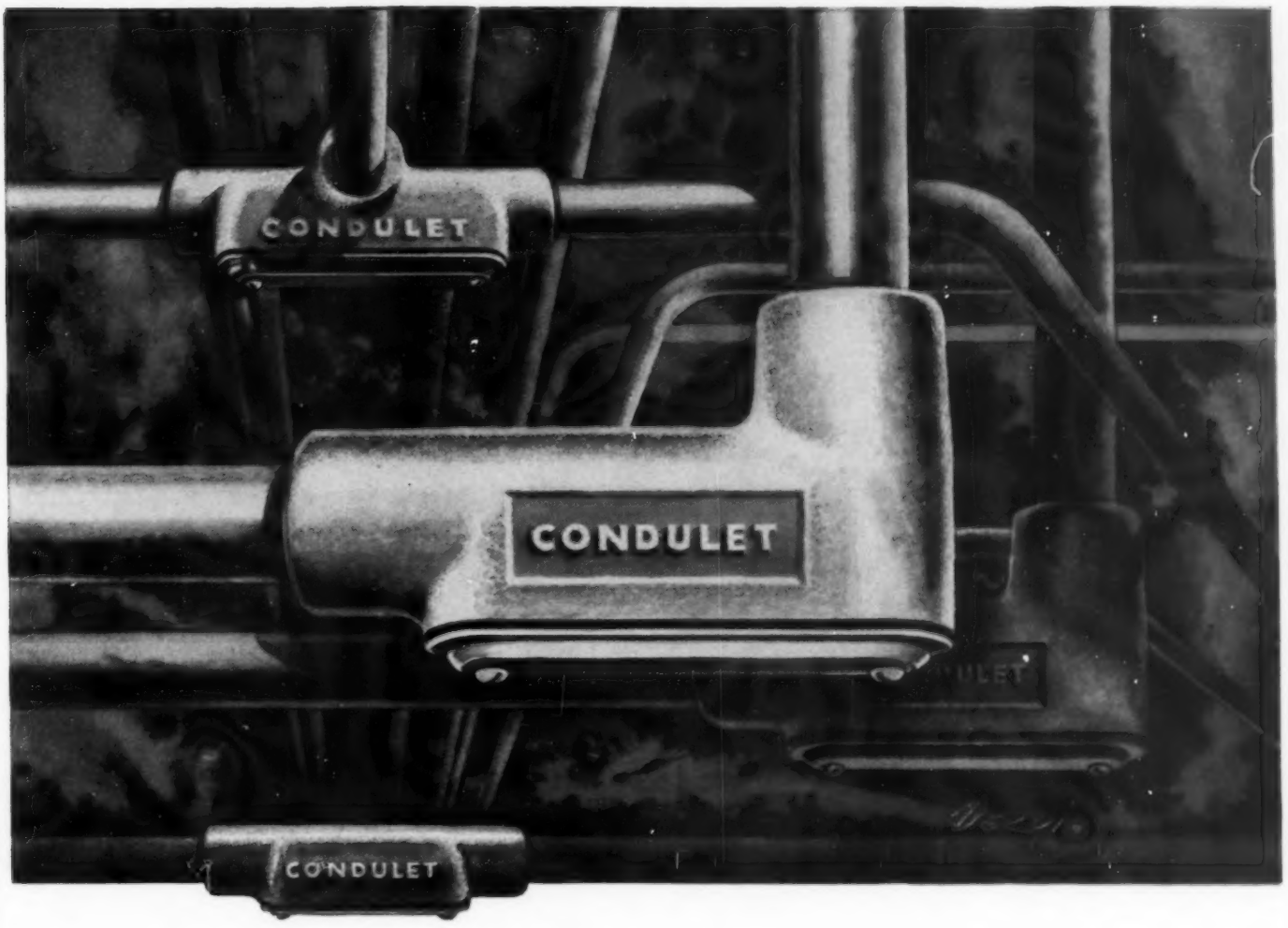
SCANNER

▲ The Baldwin-Lima-Hamilton Corp.'s 50-point automatic scanning recorders for SR-4 strain gages and SR-4 transducers have been improved to accommodate both two and four arm strain gage bridges, to provide greater flexibility of opera-

(*Please turn to page 239*)

Nothing Beats

CONDULETS* and RIGID CONDUIT for FLEXIBILITY, SAFETY, ECONOMY



- **INSTALL ANYWHERE.** Crouse-Hinds Condulets and rigid conduit operate safely and efficiently under all atmospheric conditions and in all occupancies.
- **INCREASE CAPACITY EASILY.** You don't have to tear out and replace the entire system: merely pull additional wires or put in a larger size.
- **ASSURES MAXIMUM SAFETY.** Condulets are Taper-Threaded to provide a permanent low resistance path to ground.
- **GREATER DURABILITY.** Condulets and rigid conduit provide circuits with more protection against physical damage than any other wiring system. Further, Condulets are made of galvanized cast Feraloy, and resist corrosion.
- **LOWER OVER-ALL COST.** First cost is the entire cost — a minimum of maintenance is required.

COMPLETE FLEXIBILITY

There's a Condulet to meet every need of complex modern electrical layouts. See your Condulet Catalog.

A NATIONWIDE DISTRIBUTION exclusively through ELECTRICAL DISTRIBUTORS

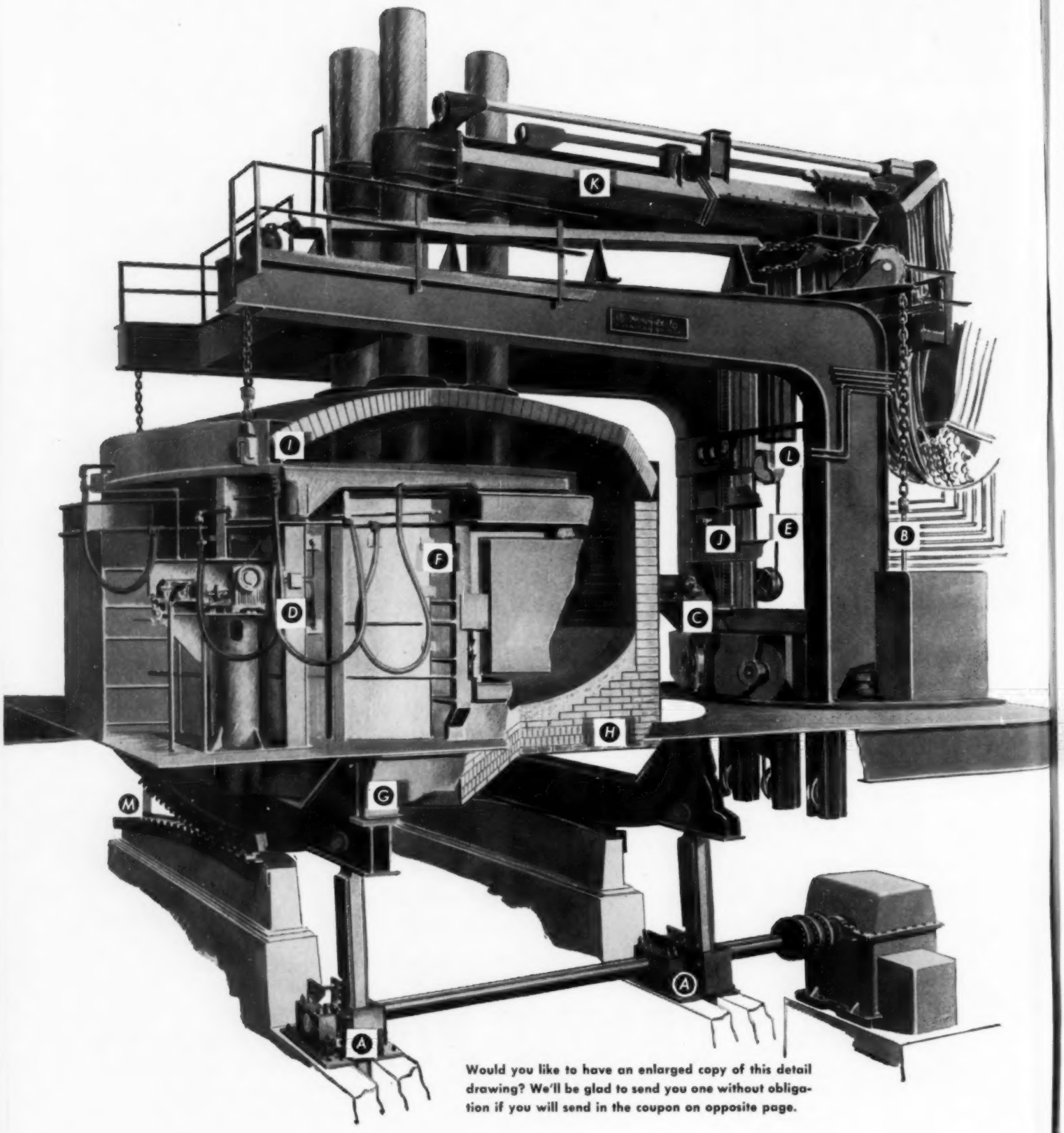
*CONDULET is a coined word registered in the U.S. Patent Office. It designates a product made only by the Crouse-Hinds Company.

CROUSE-HINDS COMPANY

Main Office and Factory: Syracuse, N. Y.
Crouse-Hinds Company of Canada, Ltd.: Toronto, Ont.

OFFICES: Birmingham Boston Buffalo Chicago Cincinnati Cleveland Dallas Denver Detroit Houston Indianapolis Kansas City Los Angeles Milwaukee New Orleans New York Philadelphia Pittsburgh Portland, Ore. St. Louis St. Paul San Francisco Seattle Tulsa Washington RESIDENT REPRESENTATIVES: Albany Atlanta Baltimore Baton Rouge Charlotte Chattanooga Corpus Christi Jacksonville Reading, Pa. Richmond, Va. Shreveport

Ten (10) reasons why
is the finest electric furnace



Would you like to have an enlarged copy of this detail drawing? We'll be glad to send you one without obligation if you will send in the coupon on opposite page.

We welcome **an opportunity to help you select and install the Heroult Furnace best suited to your requirements. Remember—*the Heroult we make and install for you will be the finest electric melting furnace that money can buy!***

the NEW Heroult on the market!

To HELP YOU PRODUCE better quality steel faster and more economically, we have made important design improvements in the long-famous Heroult electric melting furnace. Five of the features shown in the cutaway drawing at the left and described below are to be found *only* in the new Heroult. *All ten* of the illustrated features are important to those interested in the most modern melting equipment. Any way you look at it—performance efficiency, operating economy, or low-cost maintenance—this *new* Heroult is unquestionably the *finest* electric melting furnace on the market.

1. The Heroult Furnace is *the only 100% mechanically operated electric furnace.*

It includes such mechanical features as: (A) heavy rack-and-pinion-type tilting mechanism, (B) mechanical roof lift, (C) motor-driven, rotating, jib-type roof swing, (D) winch-operated, water-cooled, jib-type door-lifting mechanism, and (E) high-speed, electro-mechanical electrode-positioning mechanism.

2. *Another exclusive* — Cage-type shell construction with shell plates loosely attached (F) to a heavy supporting structure.

This construction minimizes shell warping and allows easy replacement of damaged shell plates.

3. *Exclusive*—Operating mechanism independently supported.

The tilting platform on which all operating mechanisms are supported is attached directly to the rockers independent of the shell structure (G). Thus operating mechanisms are unaffected by any shell distortion.

4. *Exclusive*—Flat Bottom Shell.

This feature (H) facilitates easy shell relining and provides maximum protection against burnouts. Thicker refractory at the sides of the hearth promotes more uniform bath temperature.

5. *Exclusive* — Water-cooled, Skew Back Roof Ring.

This feature (I) eliminates the need for special skew-shaped roof refractories.

6. Electrode Mast Safety Device.

This spring-loaded, rack-and-pawl-type device (J) provides positive protection against damage resulting from electrode winch cable breakage.

7. Square-Section, Water-Cooled Electrode Mast Arms.

This design (K) guarantees a rigid connection between mast and mast arm, thus helping to maintain proper electrode position.

8. Remote-Controlled Electrode Clamps.

This device, of the spring-clamp, air-release type, is located inside of the rear section of the water-cooled mast arm where heat cannot affect it.

9. Square-Sectioned Electrode Mast.

This design feature (L), developed by American Bridge, assures proper guiding and electrode positioning.

10. Rockers.

The heavy fabricated steel curved top and bottom rockers (M) minimize forward travel during tilting. These rockers are so designed that the furnace will tend to return to horizontal position from any degree of tilt.

THE NEW

Heroult

ELECTRIC FURNACES

are available in:

—sizes of shell diameter ranging from 7′ 0″ up, and with capacities of from 6,000 lbs. up to 400,000 lbs. and greater. They are equipped with roof-removing mechanism to permit fast top charging. They can readily be furnished with a non-magnetic shell bottom section to accommodate induction-stirring equipment.

Gantry-type top-charge furnaces, door-charge furnaces, and special furnaces for duplexing and non-ferrous melting can also be supplied.

Heroult

ELECTRIC MELTING FURNACES

Send coupon for catalog and/or enlarged copy of detail drawing with special installation and engineering data.

American Bridge Division
525 William Penn Place, Dept. SE-116
Pittsburgh 30, Pa.

Please send me a copy of the latest Heroult Electric Furnace catalog ( ) and/or your new folder showing large drawing with special installation and engineering data ( ).

Name ..... Title.....

Firm Name .....

Address .....

City ..... State.....

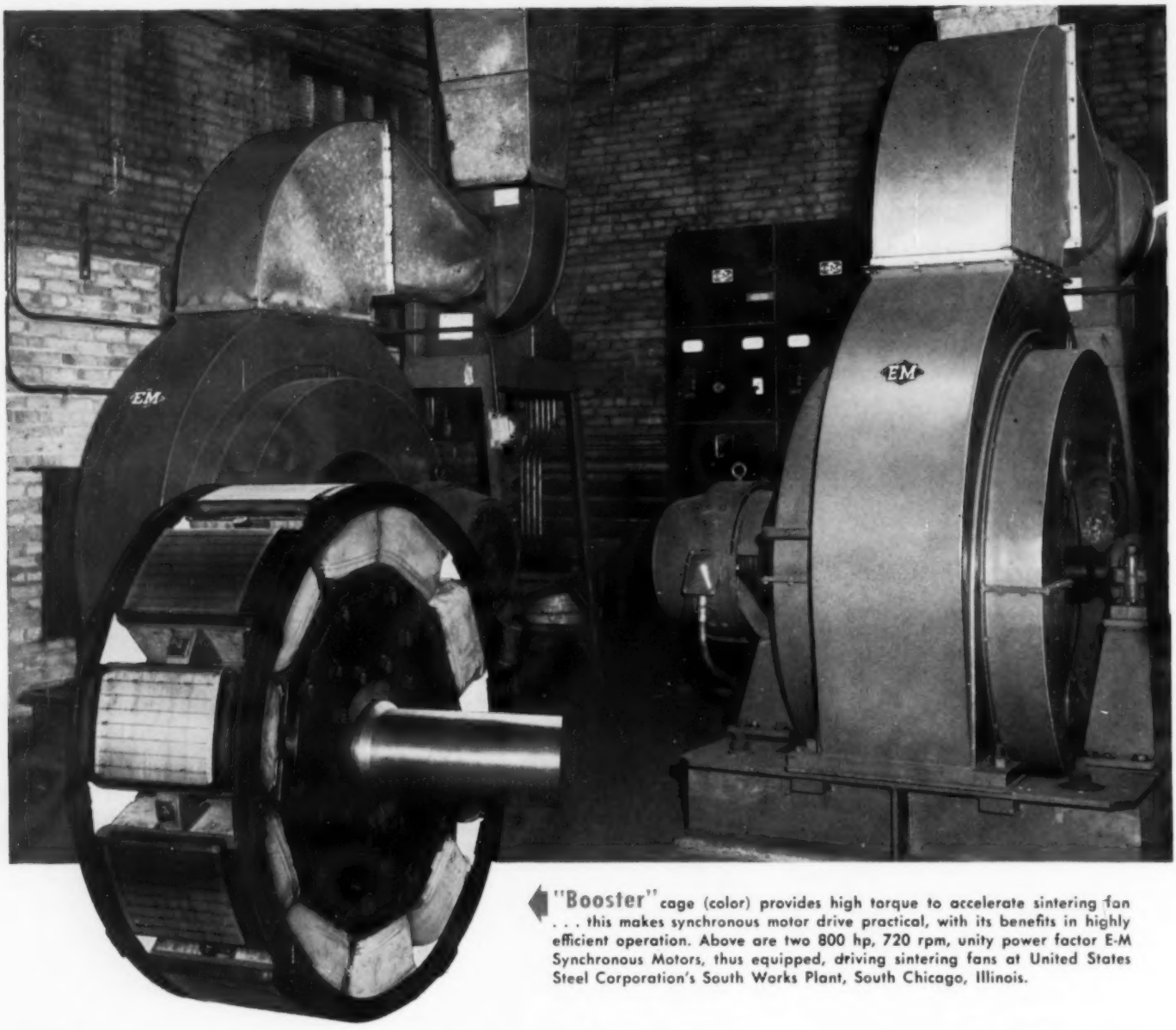
AMERICAN BRIDGE DIVISION

UNITED STATES STEEL CORPORATION, GENERAL OFFICES: 525 WILLIAM PENN PLACE, PITTSBURGH, PA.

Contracting Offices in New York, Philadelphia, Chicago, San Francisco, and other principal cities.

United States Steel Export Company, New York

UNITED STATES STEEL



"Booster" cage (color) provides high torque to accelerate sintering fan . . . this makes synchronous motor drive practical, with its benefits in highly efficient operation. Above are two 800 hp, 720 rpm, unity power factor E-M Synchronous Motors, thus equipped, driving sintering fans at United States Steel Corporation's South Works Plant, South Chicago, Illinois.

How to drive a sintering fan most profitably

● There are sound reasons why synchronous motors (such as the installation above) are the most economical sintering fan drives. Consider your power bill . . . the high efficiency of the synchronous motor produces maximum usable horsepower from a minimum of electric power. Your entire electrical system will benefit from power factor improvement through the unique ability of synchronous motors to correct lagging power factor. You save on power costs both ways. And motor maintenance costs are low too.

However, the fans have a large WK^2, and sintering begins with a cold bed. So, E-M engineers developed a special double-deck starting cage for these difficult starting and synchronizing requirements. Here's what it does:

Characteristics of this E-M extra-heavy-duty double-cage winding are such that uniformly high torque is provided for both starting and pull-in. This E-M winding not only accelerates the heavy fan, but also provides that powerful "boost" to 98½ % of synchronous speed needed to pull it into step.

Further assurance of powerful synchronizing is offered by the E-M-invented Polarized Field Frequency Control which automatically applies field excitation at the instant when rotor angle will give maximum synchronizing power with no pole slippage. Current inrush is held at a minimum.

E-M's pioneering and long experience in synchronous motor applications have resulted in many profitable steel plant installations. Ask your nearest E-M sales engineer for his practical suggestions on your requirements.

ELECTRIC MACHINERY MFG. COMPANY
Minneapolis 13, Minnesota

1100-TPA-2146

E-M

Specialists in making motors do
EXACTLY WHAT YOU WANT THEM TO

(*Continued from page 234*)

tion and more useful data presentation, and to offer an additional lower strain range.

These new models of the recorder, now being built by the firm's Electronics and Instrumentation Division at Waltham, Mass., greatly reduce the time and skill required to conduct multi-point load-strain tests on structures because they plot percent of load versus strain curves for each channel directly on the chart.

The accommodation of both two and four arm strain gage bridges permits automatic measurements either with such SR-4 transducers as standard load cells or with resistance wire strain gages. In any combination up to the limit of 50 bridges, the recorder will step in sequence through each channel, plot a point for each and then stop. The equipment plots a complete sequence of 50 points in 30 to 90 seconds, depending on strain levels.

In addition to the flexibility of bridge types that may be used, the instrumentation of the recorder will accommodate strain gage resistances ranging from 60 to 500 ohms with gage factors from 2.25 to 1.77. Each of the 50 channels has an individual zero potentiometer and the recorder has a selector switch to index zero at right, left or center on the chart.

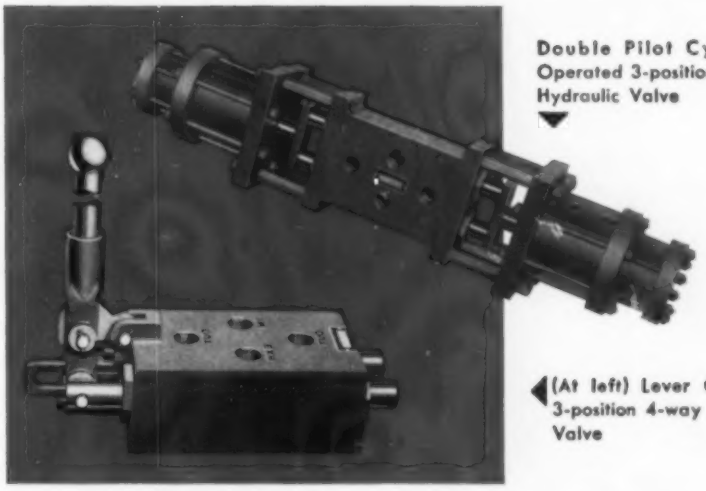
To the ranges on the abscissa of the chart, where strain is plotted against a scale of 0 to 100 units, a fourth range of 0 to 1000 micro-in. has been added to the previously available ranges of 0-2000, 0-5000, and 0-10,000 micro-in. This addition permits greater accuracy in reading strains of small magnitude.

The ability of the new recorder to plot individual percent of load versus strain curves automatically for each channel eliminates the need to plot points manually to analyze test results. The recorder provides for manual advance of the chart in percent of load increments applied to the structure to give the ordinate reading. Thus, with load plotted against an ordinate scale of 0 to 100 per cent, and strain against the abscissa, a 4 in. x 10 in. curve of plotted points results for each channel.

The recorder is equipped with a chart skipping mechanism to conserve chart paper when less than 50 channels are being scanned.

To minimize switching resistances,

Quick-As-Wink® HYDRAULIC VALVES



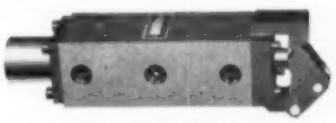
Double Pilot Cylinder Operated 3-position 4-way Hydraulic Valve

(At left) Lever Operated 3-position 4-way Hydraulic Valve

Hand and Pilot-operated Types for water or hydraulic oils to 5000 psi.

• These valves give users maximum efficiency, economy and dependability. Housings are milled from steel blocks or bronze forgings. The hollow, radially ported, stainless steel plungers are hard chrome plated and polished. Renewable metal valving rings assure long life of the packers which are expanded by internal pressure . . . the higher the pressure the tighter the seal. No metal to metal seating. The valves are fully balanced in any position. Inspection — and servicing if necessary — can be done easily *in the field,* avoiding the delays of returning valves to the factory for servicing, or the need to carry large inventories of standby valves — or even parts. Complete dimensions, capacities and other data sent promptly. Write for Bulletin No. 531,— Today!

Ask us also about . . .



CAM OPERATED SINGLE PLUNGER VALVE ⅜" to ¾" sizes. Operated by rotating cam or land on reciprocating device.

DOUBLE SOLENOID "O-TYPE" VALVE for pressures up to 125 psi. Widely used as pilot valves and for operating air cylinders.

Quick-As-Wink® AIR AND HYDRAULIC Control Valves

Hand, Foot, Cam, Pilot, Diaphragm and Solenoid Operated

Mfd. by C. B. HUNT & SON, INC., 1921 East Pershing St., Salem, Ohio

the scanning switch of the recorder is equipped with gold-plated contacts, and two sets of switch poles are provided for connecting each function into the recorder.

MOTOR

▲ The "Synduction" motor, a synchronous induction machine which is providing dependable constant speed, simplicity of operation and low first cost in a variety of industrial applications requiring 40 hp and below, is available from Allis-Chalmers Manufacturing Co.

Supplying high efficiency and relatively high power factor, variable speed operation by variable frequencies up to and above 300 cycles and speeds above 10,000 rpm are possible with specially designed versions of the unit. Operations as low as 10 cycles and 200 rpm has also been obtained.

Available in drip-proof, splash-proof, totally-enclosed, and explosion-proof designs, the motor is being used for constant speed applications, adjustable speed applications, and in miscellaneous applications: for bristle cutting, wire drawing, in transfer lines of machine tools, packaging and folding machinery, and for metering positive displacement type pumps, proportioning units, and conveyors.

FURNACE

▲ A new 12-in. capacity vacuum arc melting furnace for production melting of molybdenum and molybdenum alloys is being installed at the Universal Cyclops Steel Corp., Bridgeville, Pa., plant.

The consumable electrode vacuum arc furnace will be used for development and production of high-temperature metals and alloys, with initial work in molybdenum. The furnace can also be used for iron or nickel base alloys, titanium and zirconium.

This type of melting furnace was chosen because very pure, high-quality ingots are required. It not only eliminates impurities from the atmosphere but also removes gaseous impurities at melting temperatures, reduces segregation and produces a superior grain structure.

Rated as a 12-in. furnace, the unit will also handle 8-, 10-, and 16-in. diameter ingots, with a maximum length of five and one-half ft and weighing from 850 to 5000 lb. The furnace was designed and built by the General Electric Co.'s Industrial Heating Department, Shelbyville, Ind.

The furnace consists basically of three sections—electrode housing, water-cooled copper crucible and a transition section which joins the electrode housing, vacuum system and power supply with the supporting structure.

In the vacuum arc melting process a very heavy bead is laid vertically in a water-cooled copper crucible which forms a round ingot. During the operating cycle, a high capacity vacuum system removes gaseous impurities at melting temperatures. Because of the vacuum system, the electrode is enclosed in a water-cooled tube.

As the "bead" solidifies progressively from the bottom of the crucible, the molten pool on top floats non-gaseous impurities to the sur-

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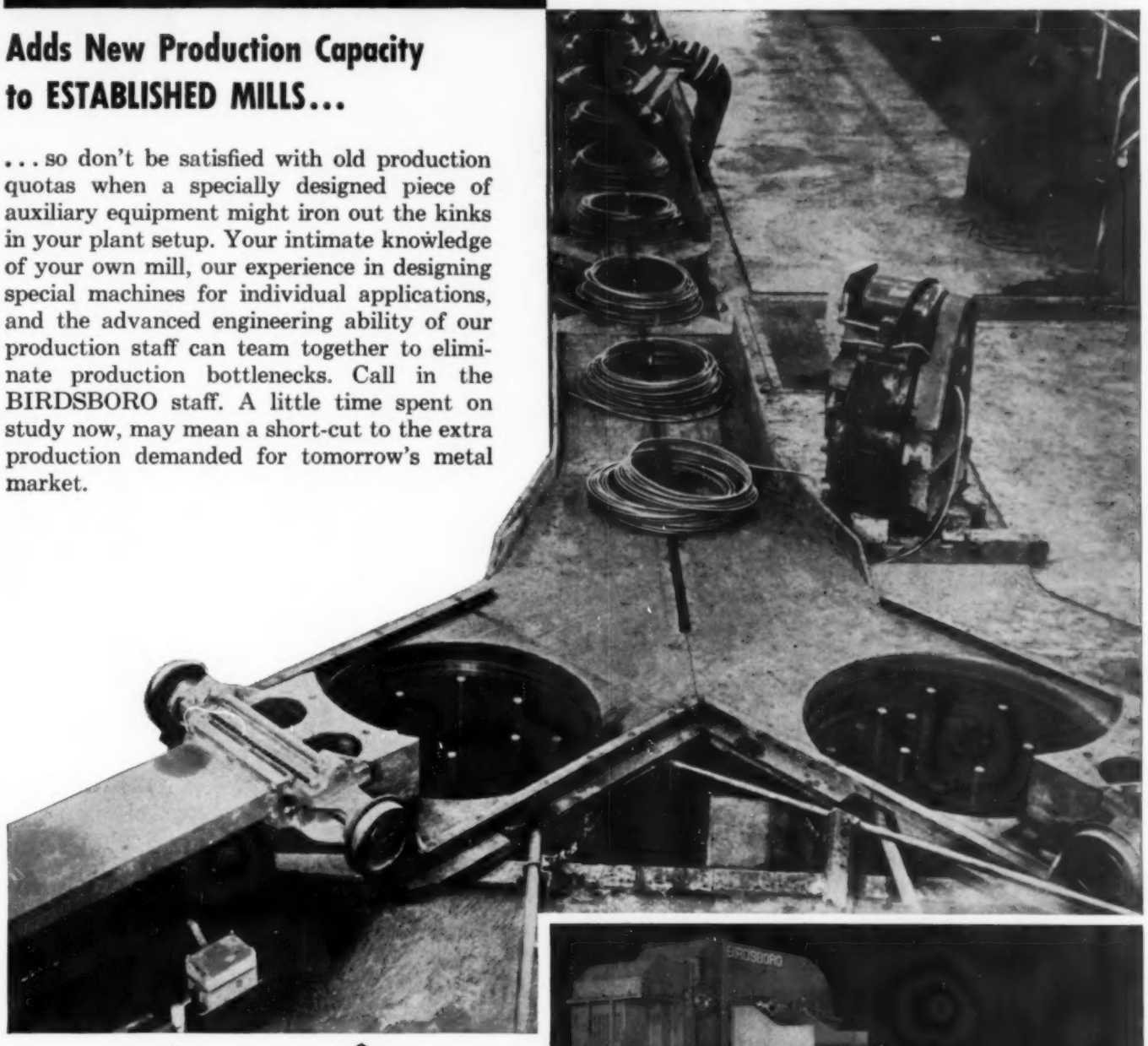
Adds New Production Capacity to ESTABLISHED MILLS...

... so don't be satisfied with old production quotas when a specially designed piece of auxiliary equipment might iron out the kinks in your plant setup. Your intimate knowledge of your own mill, our experience in designing special machines for individual applications, and the advanced engineering ability of our production staff can team together to eliminate production bottlenecks. Call in the BIRDSBORO staff. A little time spent on study now, may mean a short-cut to the extra production demanded for tomorrow's metal market.



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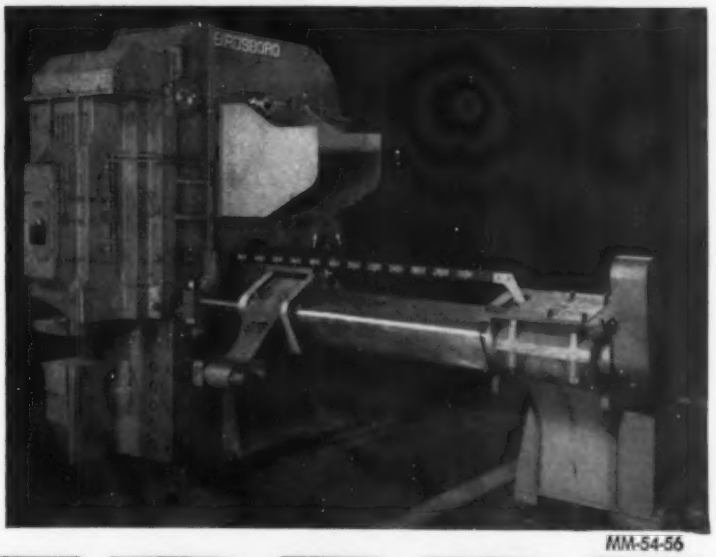
- HYDRAULIC PRESSES *(Metalworking and Extrusion)*
- CRUSHING MACHINERY
- SPECIAL MACHINERY
- STEEL CASTINGS
- Weldments "CAST-WELD" Design
- ROLLS: Steel, Alloy Iron, Alloy Steel

20"-18"-14"-12"-10" Combination Mill Rod Coilers and Rod Coil Conveyor.



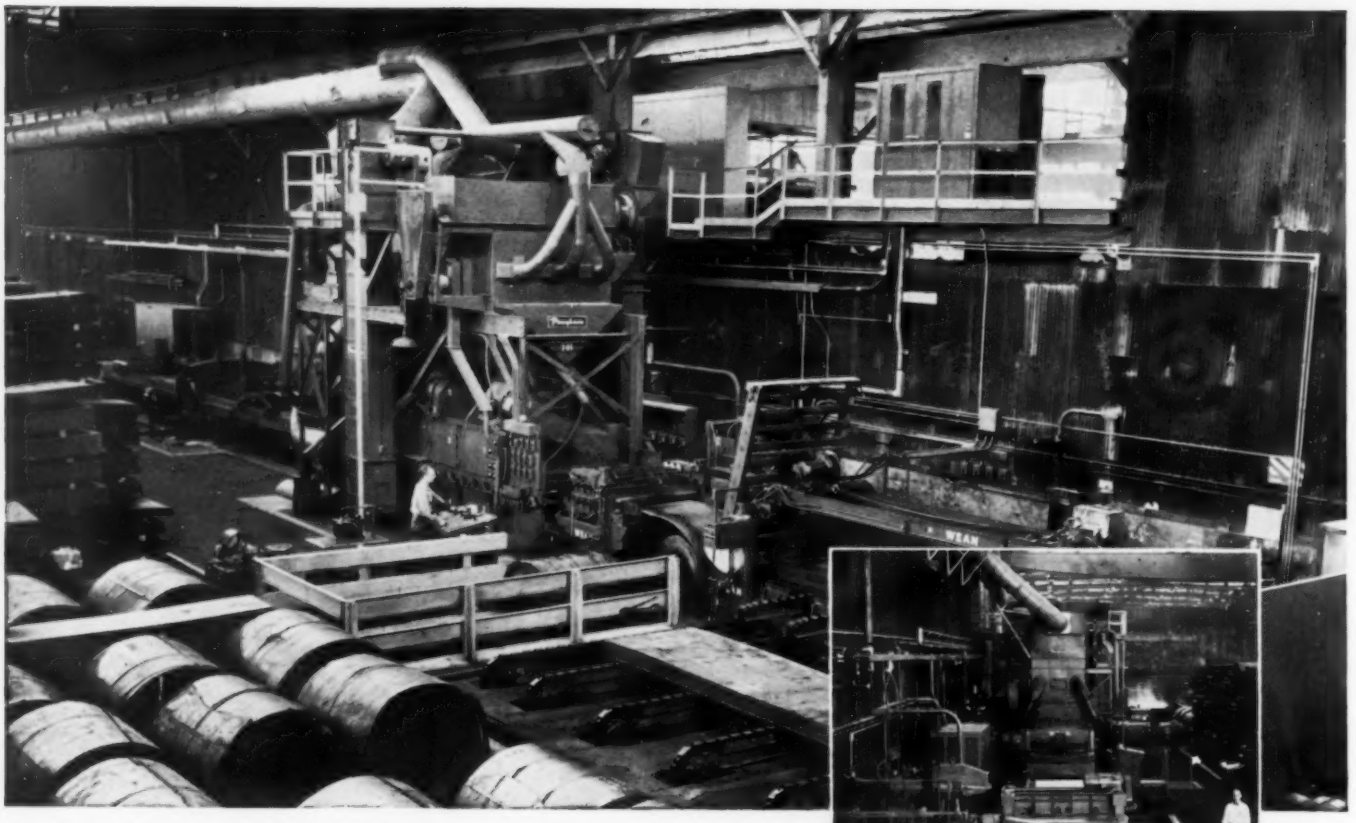
This 350-ton Birdsboro Up and Down Cut Shear and Gauge is used for hot shearing of 8" x 8" carbon steel blooms.

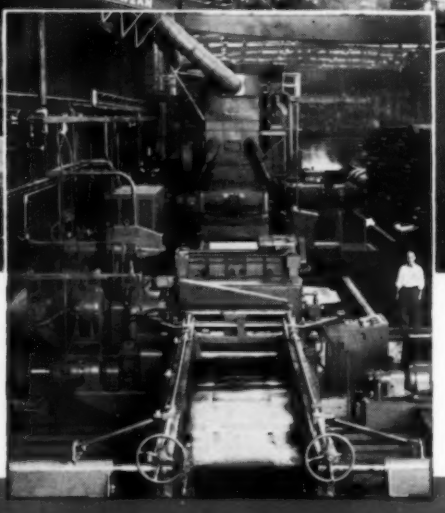
MM-54-56

BIRDSBORO

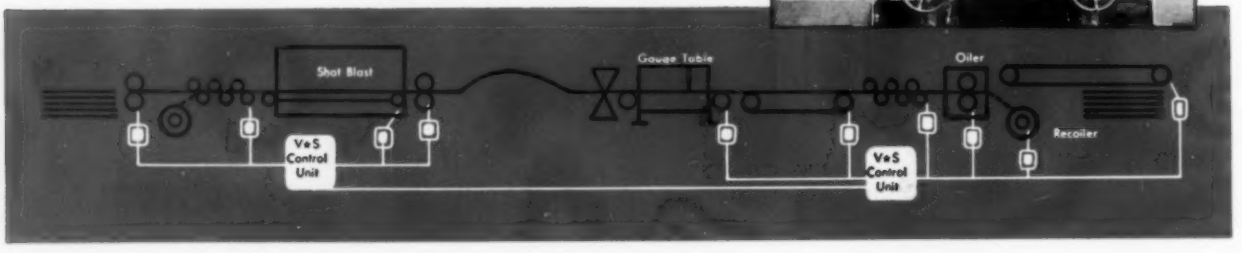
BIRDSBORO STEEL FOUNDRY & MACHINE CO., Main Offices in Birdsboro, Pa. District Office: Pittsburgh, Pa.

New York Office: **Engineering Supervision Co.,** *120 West 42nd Street, New York 36, N.Y.*





CUTS AND CLEANS UP TO 50 TONS AN HOUR— *Automatically*



It's one of the world's first automotive steel cut-up lines, owned by Parish Pressed Steel Div.—Dana Corp., Reading, Pa. This line cleans, cuts-to-length, lubricates, levels, and coils or stacks up to 50 tons of hot rolled steel an hour.

The line is made up of several separate machines —an uncoiler, a shear, a shot-blast cleaning machine, an unpiler, a lubricator, and a coil winder or stacker —all joined by a conveyor system containing pinch rolls and leveling rolls. Yet the whole line operates as one giant machine, thanks to perfect coordination provided by Reliance V★S Drives.

V★S Drives furnish an unusual flexibility to the Parish line too. Sheet speeds can be varied from 40 feet per minute up to 160 fpm. to accommodate various thicknesses and widths. From the master control, and the three supporting control stations, any one operation or combinations of operations can be eliminated from the line. Thus the line is not limited to just one set series of functions.

This application of Reliance Motors and Drives —to control tension, to synchronize operations, to regulate speed—is typical of the jobs done by the Reliance Applied Engineering Department.

L-1511

If you would like further information on the application of V★S Drives in your plant write:

RELIANCE V★S DRIVE

RELIANCE ELECTRIC AND ENGINEERING CO.

Dept. 1111A, Cleveland 10, Ohio • Offices in Principal Cities

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face. These impurities are cropped off the top of the ingot at conclusion of the melt. Progressive solidification of the ingot tends to align the grain growth parallel to the length of the ingot.

The operator's panel for the furnace is a free standing cubicle that can be mounted near the furnace or at a remote location. A simple optical system projects an image of the arc on a screen visible from the operator's panel.

The furnace will produce a 2000-lb ingot every five hours. This includes about two hours melting time, one and one-half hours for ingot removal, and one and one-half hours for preparing furnace for the next melt.

MECHANICAL SEAL

▲ A new boiler feed pump mechanical seal, developed by Crane Packing Co. is now available. Once installed, the seal needs no further attention and replacement of expensive sleeves is eliminated. Loss of valuable feed water is prevented, since there is no leakage.

Long seal life is obtained through the use of a special closed circulating system. This engineered system provides cool water in sealing chamber assuring best seal performance.

The new seal comes fully engineered for the particular operation, including adaptation to pump design and piping arrangement. Plans are furnished. All necessary recommendations are supplied and heat exchanger size is specified. This provides a complete package that can be easily installed without major stuffing box alteration.

ENTRAINMENT SEPARATOR

▲ Developed by National Carbon Co., Division of Union Carbide and Carbon Corp. is a corrosion-resistant entrainment separator for the removal of liquid particles from air and other gases. An impingement type entrainment separator made of "Karbate" impervious graphite, the type MV scrubber is a compact, self-contained unit ready for inserting in a pipe line.

Rods of impervious graphite, streamlined in cross-section, are staggered in rows within the cylinder. Although minimum clearance is one-

"LUBRIPLATE, THE OUNCE OF PREVENTION"

says VULCAN IRON WORKS, INC. of Chicago, Ill.

—a leading manufacturer of pile driving and extracting equipment

"For many years we have used LUBRIPLATE Lubricants for shop assembly, and have recommended them to our customers through your LUBRIPLATE Tag Plan. Our experience shows that if the proper lubricants are used from the beginning, there are fewer problems and parts replacements later. We consider LUBRIPLATE to be the best possible ounce of prevention."—
H. G. Warrington, Vice-Pres.

REGARDLESS OF THE SIZE AND TYPE OF YOUR MACHINERY, LUBRIPLATE LUBRICANTS WILL IMPROVE ITS OPERATION AND REDUCE MAINTENANCE

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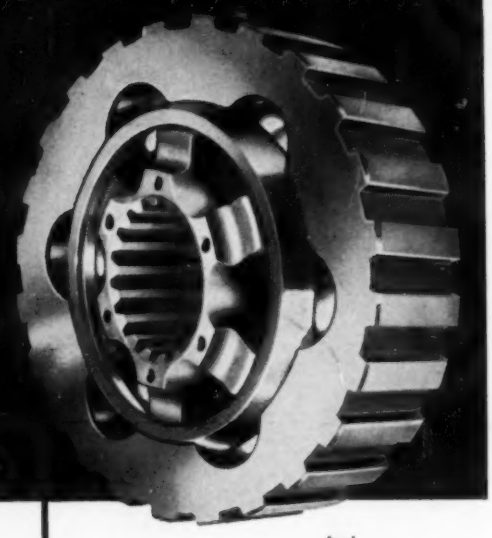
MAKES CARS AND TRUCKS RUN BETTER AND LAST LONGER

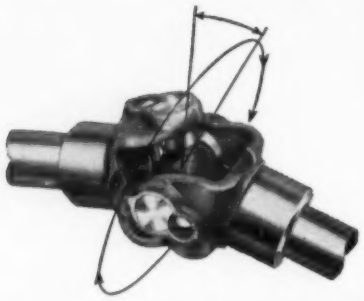
LUBRIPLATE H.D.S. MOTOR OIL . . . THE OIL THAT NEEDS NO ADDITIVES

For nearest LUBRIPLATE distributor see Classified Telephone Directory. Send for free "LUBRIPLATE DATA BOOK" . . . a valuable treatise on lubrication. Write LUBRIPLATE DIVISION, Fiske Brothers Refining Co., Newark 5, N. J. or Toledo 5, Ohio.

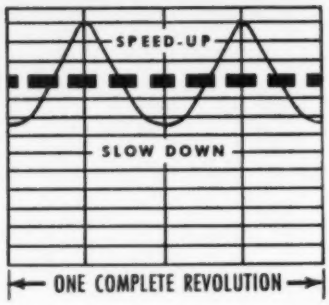
FACTS...

on a Universal Joint that cuts costs, increases production in steel-making equipment

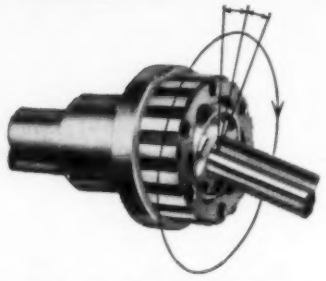




During rotation at a given angle, pin- or slipper-type joint speeds up, slows down twice during one revolution.



Solid line shows speed variation for one revolution of pin- or slipper-type joint at a critical angle. Note constant velocity of 100% for Rzeppa Joint (dotted line).



Due to its construction features, the Rzeppa Joint always transmits a smooth flow of power even at unbalanced angles. The standard joint cannot meet this test without involved compensating measures.

IN THESE TYPICAL APPLICATIONS

Among the many applications where Rzeppa Constant Velocity Universal Joints are ideally suited are:

- Blooming Mills
- Billet Mills
- Merchant Mills
- Skelp Mills
- Butt Weld Pipe Mills
- Electric Weld Tube Mills
- Hot Strip Mills
- Cold Reduction Mills
- Auxiliary Equipment

The above facts prove why you can expect superior performance when your steel-making equipment utilizes Rzeppa Constant Velocity Universal Joints. Rzeppa's *modern design* offers you all these advantages:

- INCREASED SPEEDS
- REDUCED DOWN-TIME
- LOWER MAINTENANCE
- HIGHER CAPACITIES

The next time you are considering universal joints for replacement or original equipment—why not look into the exclusive features offered only by Rzeppa.

WRITE TODAY . . . for this complete brochure which offers you many more FACTS on Rzeppa Constant Velocity Universal Joints.

RZEPPA

("SHEPPA")
CONSTANT VELOCITY UNIVERSAL JOINTS

THE GEAR GRINDING MACHINE COMPANY
3929 CHRISTOPHER, DETROIT 11, MICHIGAN
Manufacturers of: Fully Automatic Gear Grinding Machines • THE DETROIT SCREWMATIC 750

fourth of an in. which prevents clogging, a beam of light will not pass through. As the gas to be scrubbed flows through the cylinder, moisture particles impinge on the separator rods and the gas flows on through.

At a pressure of one atmosphere, the scrubber is designed for gas approach velocity of approximately 30 ft per sec, at which the pressure drop is less than one in. (water column). The pressure drop is lower under vacuum conditions. At velocities twice those designed for, reentrainment occurs, but is retarded by the tear-drop cross-section of the separator rods.

Impervious graphite materials in the scrubber are chemically inert to mineral acids, organic solvents, salt solutions, and other corrosives.

The unit can be operated at temperatures ranging from 340 F to minus 40 F, and at pressures from full vacuum to 65 psig.

It is available from stock in four internal cylinder diameters—6, 8, 12 and 16 in. Each cylinder is 22 in. long, and is designed for installation between the faces of 150-lb ASA flanges with no enlargement of the pipe line.

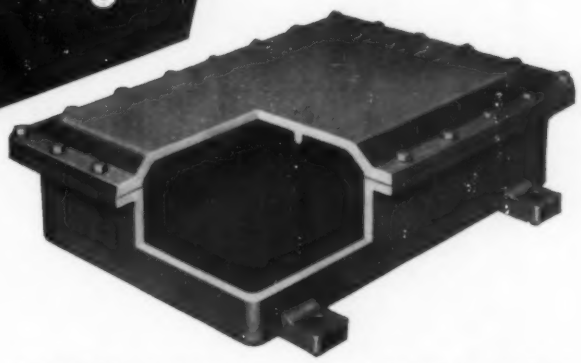
The internal separator rods are keyed in place without cement, thus permitting complete disassembly in minutes for cleaning.

HANDWHEEL OPERATOR

▲ Available from Conoflow Corp. is a handwheel operator as an integrally mounted accessory for the company's standard line of cylinder Conomotor actuators. The cylinder Conomotor a pneumatically positioned power actuator—has found industrial application for throttling control on numerous types of valves, motor driven speed changes, proportioning pumps, flow regulators, rheostats, autotransformers, etc.

The hand operator affords immediate manual control in the event of air failure. It is the only operator of its type which can be instantly thrown in and out of gear at any position of the stem travel. Clutching and declutching are accomplished simply by pulling or pushing a knob conveniently located on the face of the unit. No special tools such as pins, latching devices, hand cranks, etc., are required. When the handwheel is in declutch position, there is absolutely no interference with full and free stem travel.

Explosion-proof Housings cast aluminum



Non-sparking cast aluminum, strong and rustless. Available in a wide range of standard and special sizes.

Lightweight, easily mounts onto equipment. Drilled and tapped to specifications. Made to Underwriters and Military Specifications.

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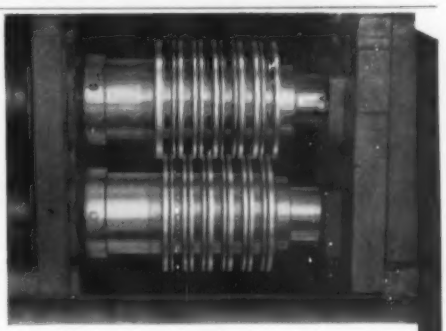
SLITTING KNIVES



Cut costs 3 ways

Cowles knives reduce set-up time. They are made so accurately they can be assembled on the arbor without shimming. Cowles knives stay on the job longer;— they reduce down-time for re-grinding; and produce straight edged strip with minimum burr avoiding tie-ups in blanking operations.

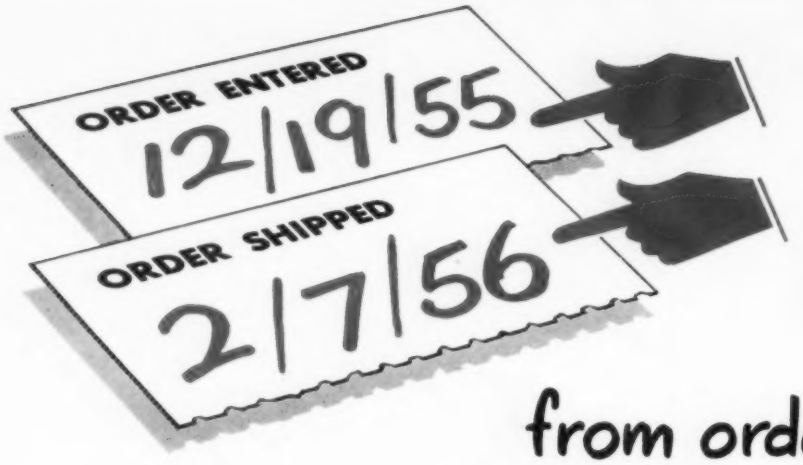
For maximum economy and satisfaction order your knives and spacers from Cowles, world's largest manufacturer of rotary slitting knives. Prompt delivery. Complete range of sizes and analyses for slitting high and low carbon steels, stainless, alloys, silicon or non-ferrous metals.

Engineering Assistance On Any Slitting Job!

COWLES TOOL CO. 2086 WEST 110th STREET CLEVELAND 2, OHIO

Specializing in the Manufacture of

ROTARY SLITTING KNIVES • SPACING COLLARS • GANG TOOLS • EDGING ROLLS • CUT-OFF KNIVES • SEAM GUIDE ROLL FINS • SEAM GUIDES • WIRE DRAWING TOOLS • STANDARD AND SPECIALLY ENGINEERED TOOLS FOR ALL FERROUS AND NON-FERROUS PROCESSING, TRIMMING AND FORMING REQUIREMENTS.



Only 50 days from order to shipment !

20,000 kva Pennsylvania Furnace Transformer

20,000-kva Pennsylvania Furnace Transformer. Three phase, 60 cycles, water-cooled. High voltage: 24,000 volts. Low voltage: 375 to 250 volts.

The order was entered on Monday, December 19, 1955. 50 days later, on Tuesday, February 7, the finished transformer was loaded on a railroad car and sent on its way to the customer. Like most other furnace transformers, this one was custom-designed and custom-built to meet limiting dimensions. Accessories and auxiliary equipment had to be located on the high voltage side and ends of the tank. Low voltage bus work had to match existing facilities.

A 50-calendar-day delivery for a 20,000-kva furnace transformer is not an everyday requirement at Pennsylvania, but when circumstances demand it, deliveries such as this can be made.

Sixteen years ago, in 1940, Pennsylvania was called upon to design and deliver a 15,000-kva, 3-phase, 25-cycle furnace transformer in record time. A large transformer by today's standards, it was even more so a decade-and-a-half ago. Pennsylvania designed, built, and shipped that transformer in 35 calendar days and it is in active service today in a large steel mill.

Which all boils down to this:

If you have a furnace transformer problem — whether it involves short-time delivery, special requirements, or unusual design problems — it will pay you to consult Pennsylvania.

PENNSYLVANIA TRANSFORMER COMPANY
A McGraw Electric Company Division CANONSBURG, PA. Greater Pittsburgh District

The unit presents a compact, streamlined appearance; it has no protruding levers, brackets or extensions. All gears are enclosed in a sturdy, lightweight aluminum housing, eliminating the possibility of dust and grit clogging the gear mechanism. Alemite fittings are easily accessible for gear lubrication.

THRUST BEARING

▲ Designed by Rollway Bearing Co. for steel applications such as pay off reel, is a hevy-duty single-acting thrust bearing with a load capacity of 116,000 lb at 200 rpm, 76,500 lb at 700 rpm, and 67,800 lb at 1000 rpm.

Extra thickness of high-grade alloy steel thrust plates (1¼ in.) insures high load capacity and extends bearing life. Plates are held to extremely close limits for parallelism for maximum linear contact. Special plates above are cantilevered to relieve inner race of radial bearing on left and outer race of radial bearing on right.

The thrust load is carried at right angles to the roll axis on 90 short, accurately dimensioned, cylindrical rollers. One roller, longer than other two in each slot, is staggered to equalize distribution of wear. Rollers are accurately spaced in machined bronze retainer, and compactly secured by a heavy steel band enclosing the retainer's outer edge. Retainer bore is widened to increase contact area and thus minimize retainer wear.

Inner space sleeve on shaft and outer sleeve in housing provide operating float.

Completing the bearing assembly are two Rollway radial roller bearings. Type MUL bearings have a load capacity of 72,000 lb at 200 rpm, 47,500 lb at 700 rpm, and 42,100 lb at 1000 rpm. Bearings have single-flange separable inner race; roller assembly is self-contained in double-flanged outer race. These flanged radial bearings are recommended because of their comparatively large thrust capacity, which permits them to take the reverse locating thrust in this type of application. Thrust load rating of this size MUL bearing, for example, is 28,000 lb at 100 rpm.

All radial rollers are crowned to relieve roller ends. The rolling surface is finish ground with a large radius for approximately one-quarter of the length of the roller on each end. This eliminates high stress points otherwise developed when two cylindrical surfaces are in rolling contact under load.

STRAIGHTENER

▲Sutton Engineering Co. announces a new machine for high-speed straightening of steel or non-ferrous pipe and tubes.

Known as Model 2JM Special, the unit will operate at production speeds up to 1000 fpm and faster, depending on the application. The first three machines are being made for continuous-weld pipe of from ½-in. to 2-in at speeds up to 900 fpm. These machines are powered by 230 volt d-c adjustable-speed motors rated 75/100 hp in a range of 400/-1600 rpm.

Incorporating the Sutton 5-roll

(*Please turn to page 256*)

Santa's Helpers

...for fifty years!

For a very special purpose, Santa has *millions* of little helpers — Christmas Seals. They give protection and help against tuberculosis—safety and care and hope, and even life itself, to hundreds of thousands of people everywhere. Make this year the best yet. Buy and use Christmas Seals.

50TH Annual Christmas Seal Sale

Because of the importance of the above message, this space has been contributed by

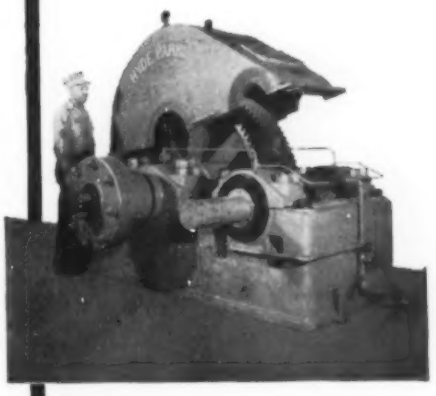
IRON AND STEEL ENGINEER

Hyde Park

RED CIRCLE Rolls ALLOY-CHILLED

Gray Iron Castings

Hyde Park Castings up to 80,000 pounds are sound, accurate and physically dependable.
Precision machining is done by skilled craftsmen in our modern machine shop.
Send your blue prints for quotation.



Mill Drive

Machine Castings
Lathe Beds
Housings
Pinion Housings
Mill Housings
Shoe Plates
Layout Plates
Surface Plates

For finer finish, long life and greater tonnage, specify Red Circle Rolls.

Hyde Park

FOUNDRY & MACHINE CO.
Hyde Park, Westmoreland County, Pa.
ROLLS
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GREY IRON CASTINGS

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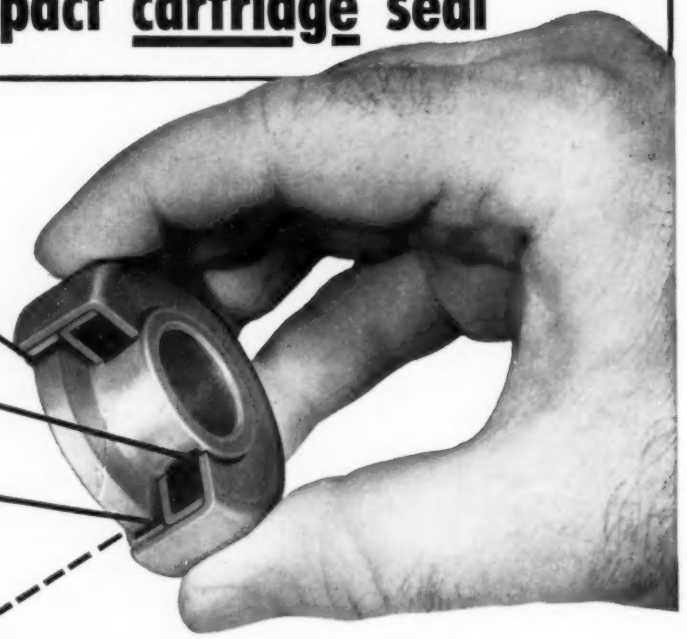
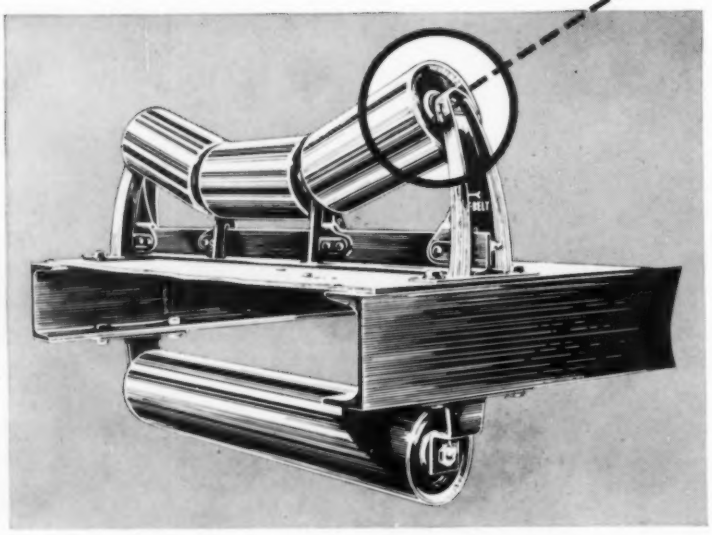
2. Contact seal
3. Clearances Grease Filled





THE effectiveness of Link-Belt cartridge grease seals in protecting belt conveyor idler bearings is matched by no other in industry. Besides the normal high efficiency of Link-Belt's labyrinth and contact seals . . . grease within the labyrinth further prevents entry of dirt or other particles. This cartridge (see above cutaway) is one integral unit—no springs, no loose washers . . . no possibility of metal-to-metal contact. From shaft to shell—bearings, fittings, rolls, frames, even hex nuts are designed for long, trouble-free life.

Also important, you can always find the *right* idler in industry's most comprehensive line—over 500 idlers in 34 types, built in a broad range of roll diameters and belt widths with matching return idlers. Ask your Link-Belt sales representative or authorized stock-carrying distributor for 48-page Book 2416, which covers this broad line thoroughly.

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BELT CONVEYOR IDLERS

LINK-BELT'S superior grease seal is standard throughout industry's most comprehensive idler line

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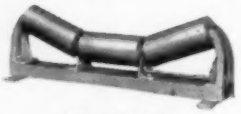
Continuous service for all but heaviest and coarsest materials.



Series 200 Idlers
Continuous service for heaviest and coarsest materials.

Series 400 Idlers
Continuous service for maximum volume per lineal foot of belt.

Series 500 Idlers
For greater volume than series 100 at maximum economy.

Series 600 Idlers
For grain and similar materials requiring only light belts.

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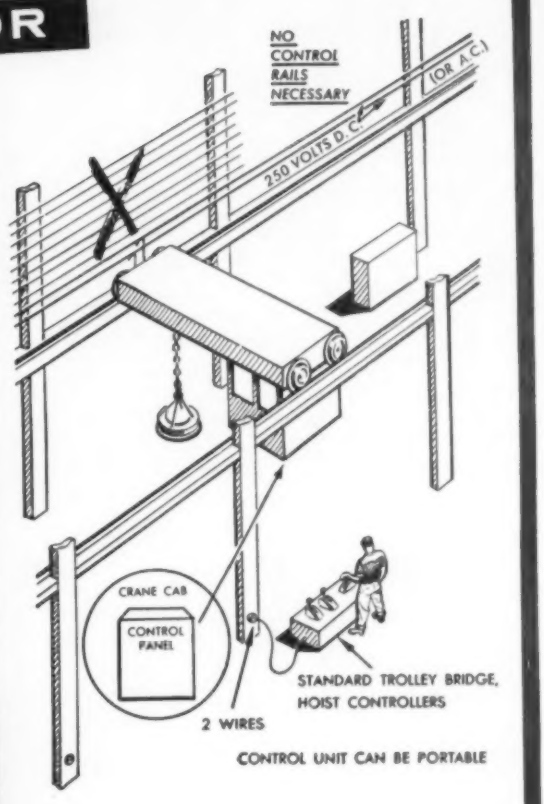

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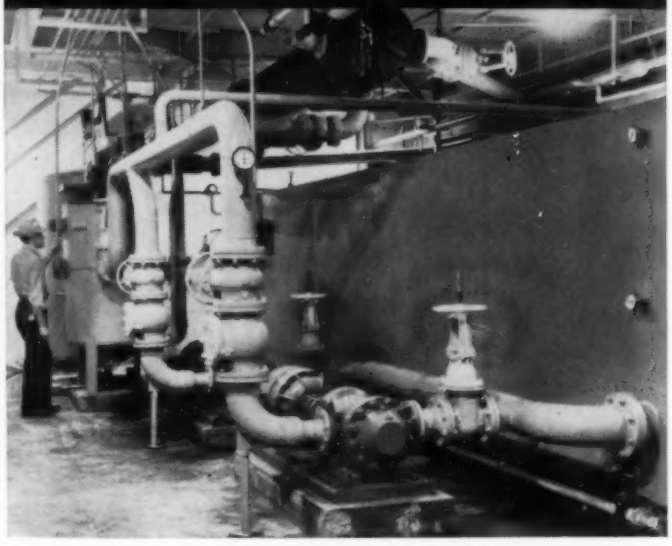

Dravo-DeLaval Lubrication and Coolant systems are designed to circulate the right amount of lubricant at the right pressure and temperature to the right spot. Dravo Lubrication systems include these four fundamentals essential to efficient mill lubrication:

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Efficient Filtering

Full flow, pressure type filters allow an uninterrupted flow of clean lubricant with minimum pressure drop.

Dravo-DeLaval systems are custom designed to match customer requirements. For installations requiring up to 50 gpm, Dravo-DeLaval Unilube units offer compact, economical "packaged" lubrication systems. For complete details, write Dravo Corporation, Dravo Building, Pittsburgh 22, Pennsylvania.

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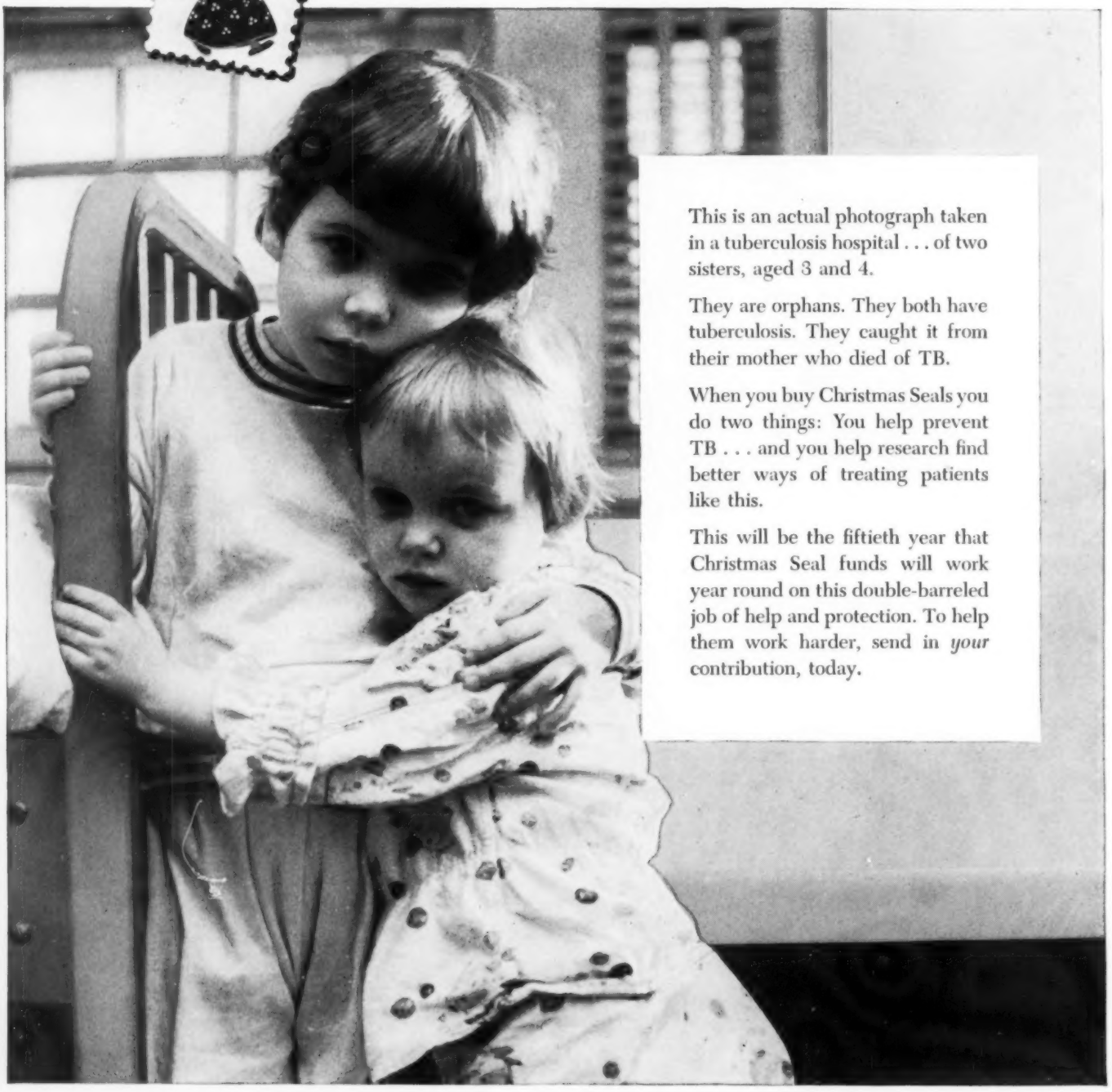

This is an actual photograph taken in a tuberculosis hospital . . . of two sisters, aged 3 and 4.

They are orphans. They both have tuberculosis. They caught it from their mother who died of TB.

When you buy Christmas Seals you do two things: You help prevent TB . . . and you help research find better ways of treating patients like this.

This will be the fiftieth year that Christmas Seal funds will work year round on this double-barreled job of help and protection. To help them work harder, send in *your* contribution, today.

50TH Annual Christmas Seal Sale

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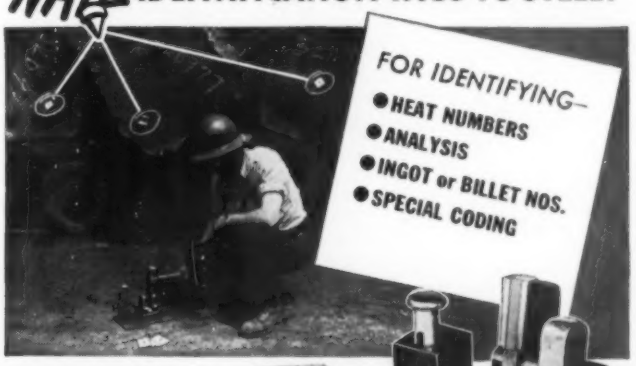

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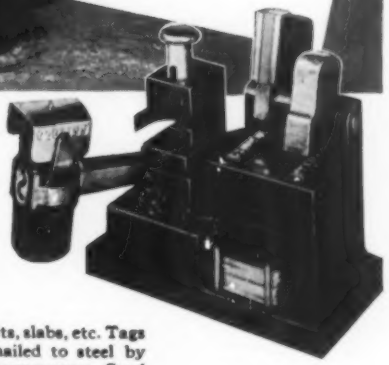

It's hard to believe, but it's true—this Outfit enables you to quickly nail metal identification tags to hot or cold steel ingots, billets, slabs, etc. Tags are embossed, pierced and nailed to steel by swinging hammer in the ordinary manner. Send for complete data today on this remarkable unit.

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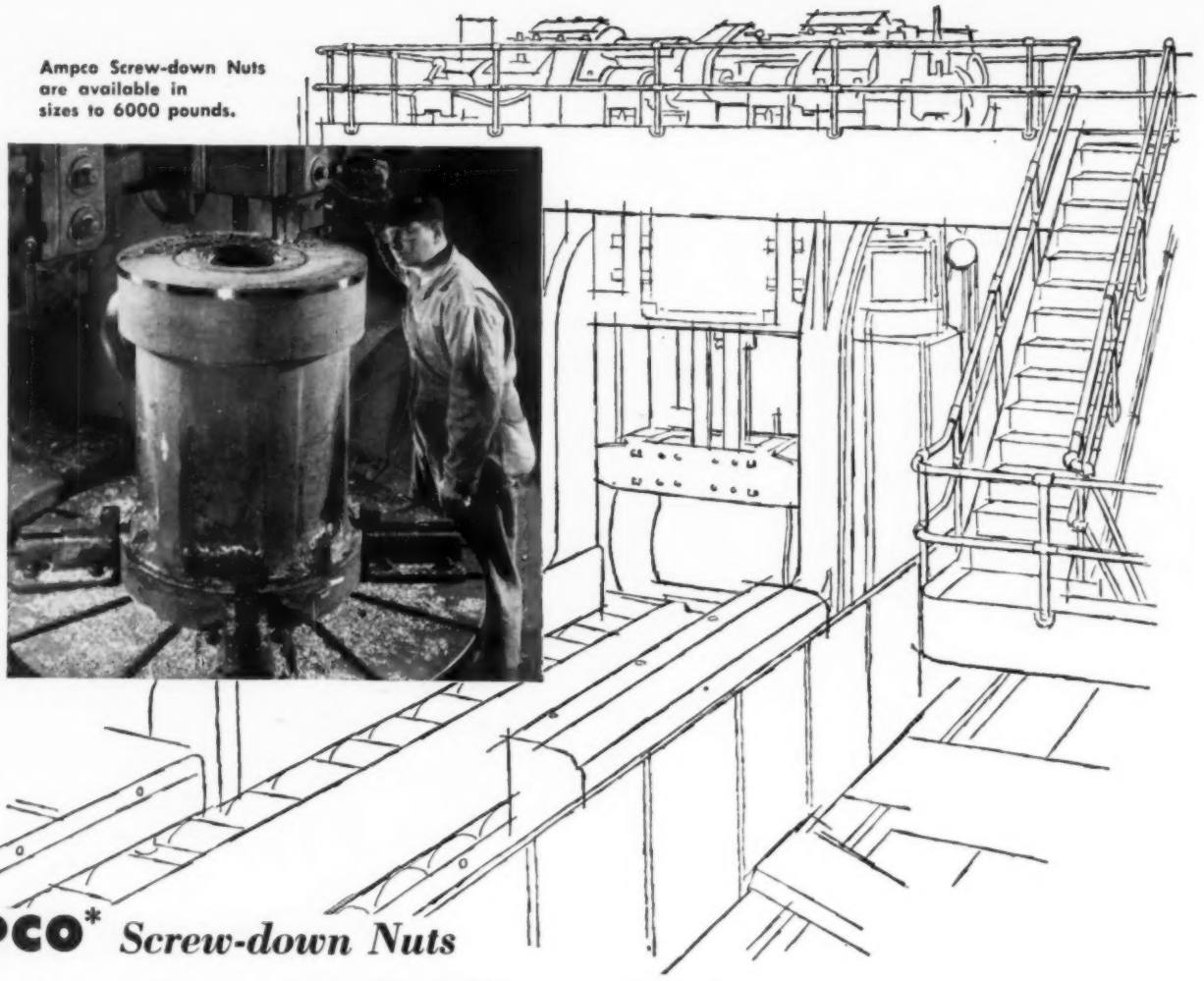


Ampco Screw-down Nuts are available in sizes to 6000 pounds.

AMPCO* *Screw-down Nuts*

help strip mill set production record

— handle extreme pressures to avert costly downtime and replacement

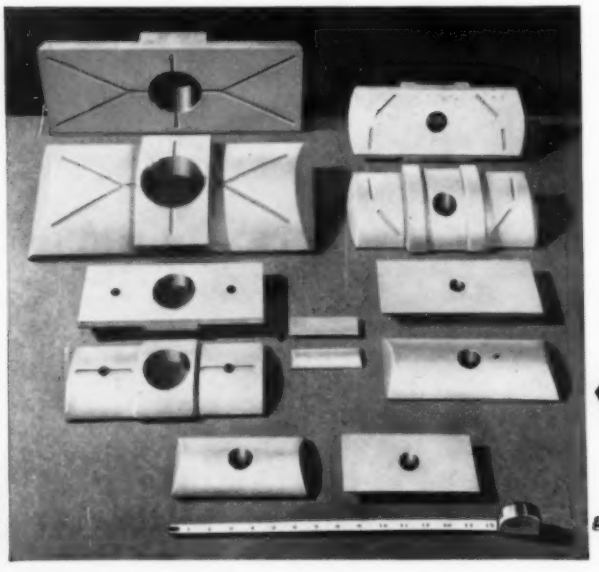
Here's where Ampco Metal's good bearing qualities, high compressive strength and ability to withstand tremendous impact and shock loads really pay off. Ampco Screw-down Nuts eliminate expensive adjustment and downtime . . . don't squash out. For example, one stand of an 80" hot strip mill using Ampco Nuts, utilizes 4500 hp at speeds up to 282 rpm. That means "king-size" stresses and strains. Yet the records show that in spite of normal screw-down pressures of between two and three million pounds, this mill produced over three million net tons of steel in 1953. Virtually no time was lost for screw-down nut replacement or adjustment.

Ampco Screw-down Nuts are centrifugally cast to insure sound structure and good wear resistance. They're available in sizes to 6000 pounds.

And Ampco slippers help keep mills running longer, too, because they have remarkable stamina . . . real resistance to wear and punishing shock loads. Mills that set production records depend on Ampco slippers to end frequent replacement — reduce spindle wear.

Slippers are available as rough castings or "cast-to-size" — minus 0, plus 1/32" or plus 0, minus 1/32". Oil grooves are cast in — if you want them.

Find out how these and other Ampco products provide real dollars and cents savings in *your* mill. Contact your nearest Ampco field engineer or write us direct.



Ampco Slippers available either as rough castings or "cast-to-size." Oil grooves can be cast in.

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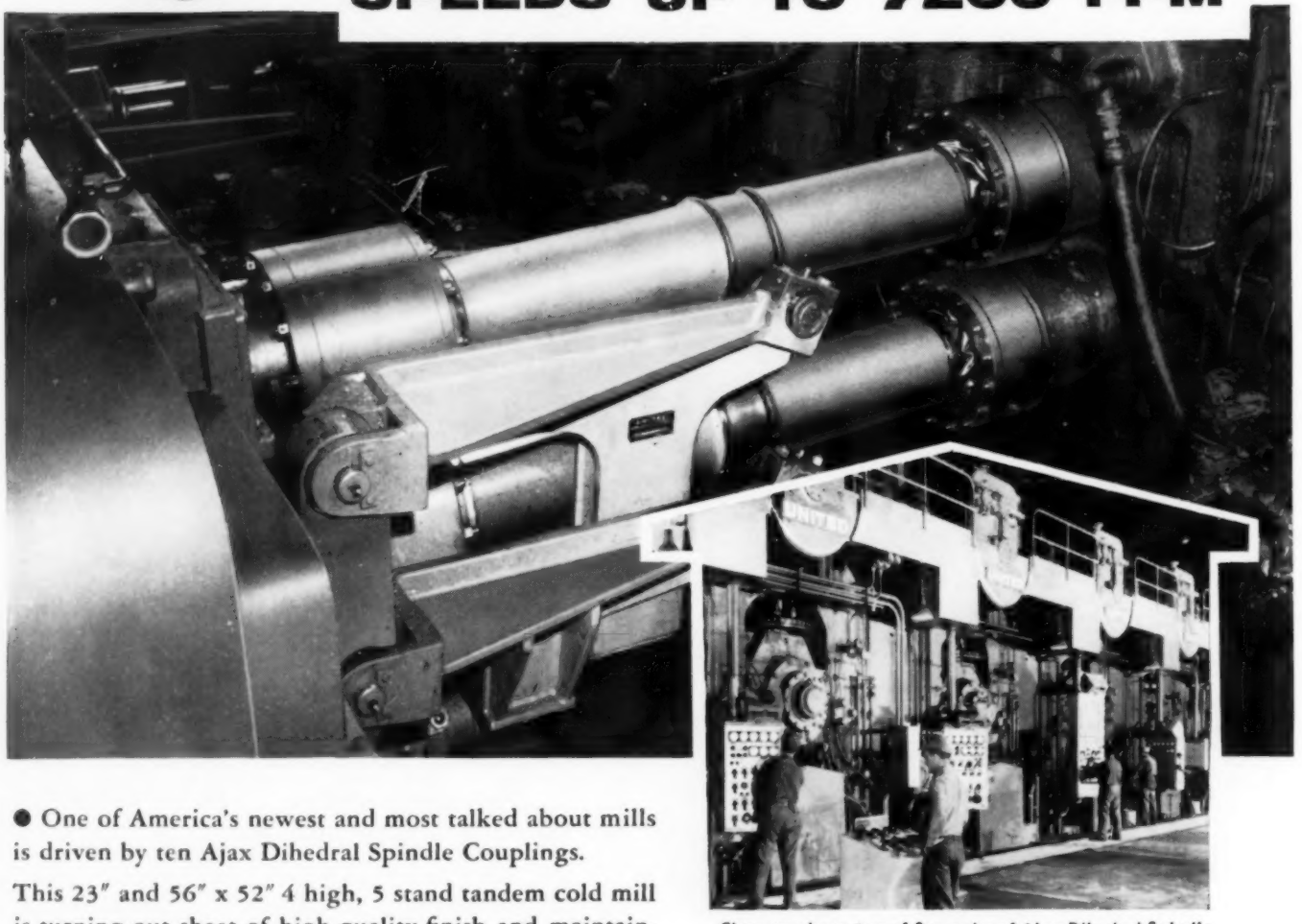
DIHEDRAL SPINDLE DRIVE COUPLINGS HANDLE SPEEDS UP TO 7200 FPM



● One of America's newest and most talked about mills is driven by ten Ajax Dihedral Spindle Couplings.

This 23″ and 56″ x 52″ 4 high, 5 stand tandem cold mill is turning out sheet of high quality finish and maintaining close gauge tolerance at speeds up to 7200 fpm.

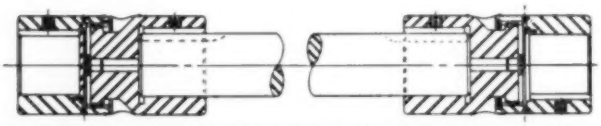
Uniform angular velocity made possible by Ajax Dihedral Spindle Couplings is an important factor in the performance of this high speed mill built by United Engineering & Foundry Co. for Weirton Steel Co., a Division of National Steel Corporation.

Each of these couplings delivers 2500 hp between drive stand and rolls.

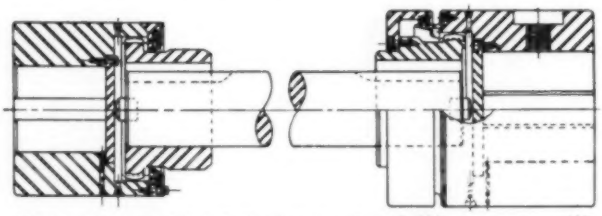
The proven performance of Ajax Dihedral Spindle Couplings is writing new standards into the specifications of mill builders and new figures into the production and maintenance cost records of mill users.

The long experience of Ajax engineers is available to help you in all phases of design, application and operation. Call in the Ajax representative or write us direct.

Close-up shows two of five pairs of Ajax Dihedral Spindle Couplings driving 23″ and 56″ x 52″ 4 high 5 stand tandem cold mill built by United Engineering & Foundry Co. in operation at Weirton Steel Co., a Division of National Steel Corporation.



Another typical style of Ajax Dihedral Spindle Shaft Couplings in several sizes for roll mill drives. Sketch shows 9″ diameter by 5′ 6″ overall length Ajax Dihedral Spindle Shaft Coupling. Arranged for booted lubricant retainer seal.



Showing Ajax Dihedral Spindle Shaft Coupling 6′ 4½″ overall with 15¾″ diameter coupling on roll end and 13¾″ diameter coupling on drive end. Rated torque capacity of this Coupling is approximately 110,000 ft. lbs.

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ELECTRICAL ENGINEER

A position of permanent status is currently available for a graduate Electricel Engineer with steel mill background. A minimum of 8 years experience required. The position requires the ability to handle problems of electric power generation, distribution, and utilization, and prepare specifications for and recommend selection of electric equipment.

All replies will be confidential. Please reply to Personnel Manager, KOPPERS COMPANY, 108 Koppers Bldg., Pittsburgh 19, Pa., by letter stating experience, salary requirements and related qualifications.

It's EASY to place a "RESULT-GETTING" Want Ad in the Engineering Mart section of the IRON AND STEEL ENGINEER.

Just fill in this form and mail it to the IRON AND STEEL ENGINEER, 1010 Empire Building, Pittsburgh 22, Pa.

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$8.00 PER COLUMN INCH.

EQUIPMENT NEWS

Continued from page 247)

principle, rolls are positioned for a horizontal pass line. A pressure roll is located between two sets of opposed rolls with each set having one opposed driven roll and one idler roll. Because only one roll of each pair of cross rolls is driven, wear is reduced and roll life lengthened. While guides ordinarily are used for safety, the machine will operate with or without guides at the option of the user.

All adjustments are readily accessible and easy to perform, there is good visibility of the working area, the machine is easy to set-up and change-over quickly with roll setting fast and sure. Longitudinal positioning of pressure rolls together with angular adjustment of all five rolls makes accurate end-to-end straightening possible over a wide range of sizes.

Construction is rugged with antifriction bearings used throughout. As the motor is mounted on top of the machine, little floor space is needed. The horizontal pass line permits scale to fall away into a disposal pit for faster, cleaner operation.

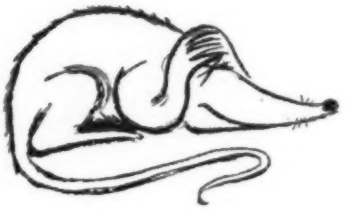
Another Sutton 5-roll model similar in basic design to the new 2JM Special, known as the 2JM Modified, is available for pipe from ½ in. to 4 in.

COMPUTING RELAY

▲ A universal pneumatic computing relay, the Model 56-1, which can be adjusted to perform any one of six different arithmetic functions is being offered by The Foxboro Co. Six other relays are also available, each designed for a specific computing operation. Measurements are received by the relay as pneumatic signals (3-15 psi); computer output to a recorder or controller is also in terms of 3-15 psi.

Consisting of a modified Model 58 Consotrol Controller with new type manifold, the new series operates on the force balance principle, with four bellows positioning a floating disc about a fulcrum. The disc acts as the flapper of a conventional flapper-nozzle detector. Forces exerted by pressures in the bellows establish the position of the disc in relation to the nozzle. The resulting pressure change in the feedback bellows maintains the balance position of the disc.

Cancer can't strike me, I'm hiding.



What I don't know won't hurt me.

Cancer?

Lots of people die of it, I know . . . but the American Cancer Society says a great many deaths from cancer are NEEDLESS *deaths. That's why I do what they tell me. I have an annual medical checkup however well I feel. I know the seven danger signals. And when I want sound information, I get it from my Unit of the*

AMERICAN CANCER SOCIETY

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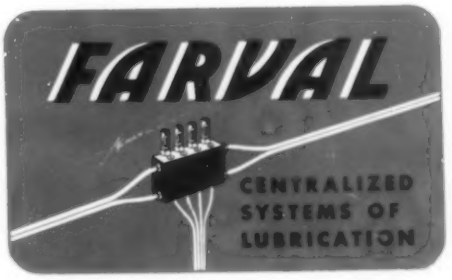

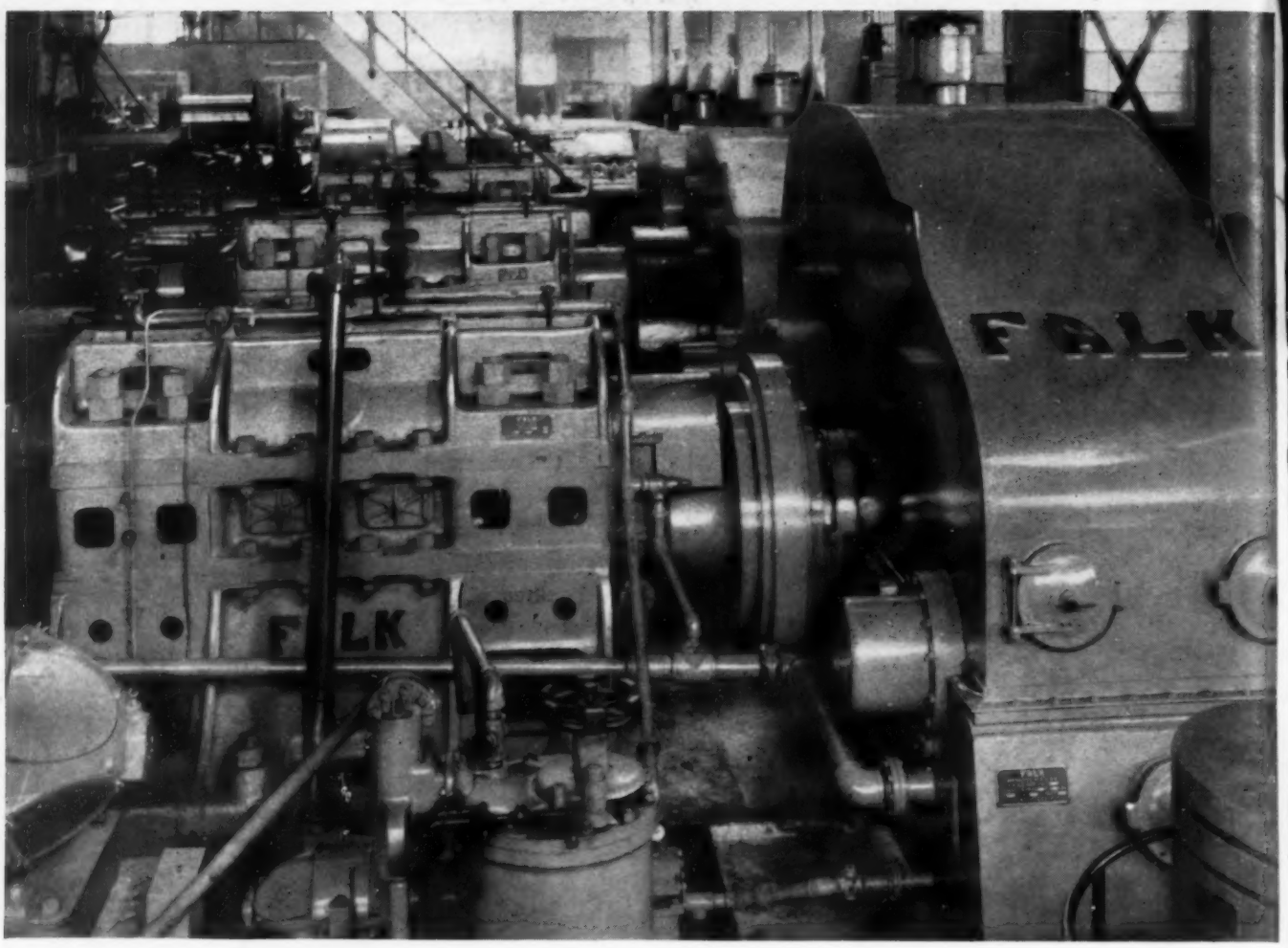

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